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Cognitive functioning and labour force participation among older men and women in England

David Haardt

SEDAP Research Paper No. 222

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Cognitive functioning and labour force participation among older men and women in England

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Abstract

This paper analyses the relationship between cognitive functioning and employment among older men and women using data from the English Longitudinal Study of Ageing. Regression analysis shows that the change in cognitive functioning over time does not have any statistically significant effects on the probability to exit or enter employment, or on working hours. These results are not sensitive to the definition of work. My findings differ from earlier research on younger age groups in Germany and the USA where some effects of cognitive functioning on labour force participation were found.

Keywords: Ageing; Cognitive functioning; ELSA; Labour force participation

JEL Classifications: H19, J14, J22, J24, J26

Résumé

Nous analysons la relation entre le fonctionnement cognitif et l'emploi chez les personnes âgées en nous appuyant sur les données de l'étude longitudinale anglaise sur le vieillissement (ELSA). L'analyse de régression montre que le changement du fonctionnement cognitif n'a pas des effets statistiquement significatifs sur la probabilité de quitter ou de rentrer sur le marché du travail ou sur le nombre d'heures travaillées. Ces résultats ne dépendent pas de la définition du travail. Mes résultats diffèrent des études antérieures portant sur des jeunes allemands et américains suggérant l'existence de quelques effets significatifs entre le fonctionnement cognitif et la participation au marché du travail.

1 Introduction

Increasing the labour force participation of older men and women may be an important channel through which to finance the costs of population ageing. As Figure 1, from Haardt (2007), shows, the proportion of men and women working in the UK falls dramatically with age, with the decline starting to set in at a rather young age when compared to the USA (see discussion in Haardt 2007). Therefore, it is important to understand the factors influencing older people's work decisions.

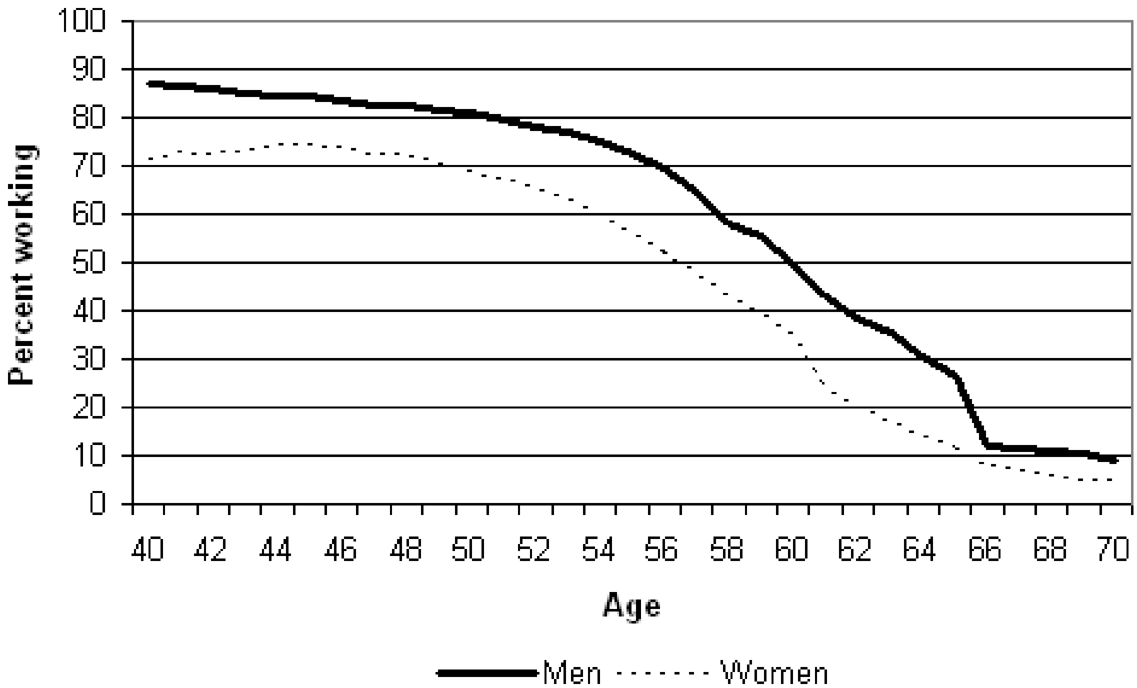

Figure 1: Proportion of men and women working in the UK, by age (own analysis using pooled BHPS data: see Haardt 2007).

Previous research has studied the effects of many different factors on participation, including health and financial incentives. Haardt (2007) showed that potential income out of work and health status are two important determinants of older men and women's labour market transitions in the UK, with effects that are larger than found in previous studies for

British and US men.

However, there are also other factors that determine whether an older man or woman works or not. Cognitive functioning (CF) may be an important factor—even low-skilled manual jobs have certain requirements on memory function and other aspects of cognition. Individuals unable to meet these requirements may find it difficult to retain their job, or to find one. The OECD, in a report on the consequences of population ageing, suggested that '[t]he present employment problems of older workers seem to be rooted in their relatively low levels of foundation skills, such as literacy and numeracy' (OECD 1998: 85). However, they do not present any empirical evidence for this claim.

To the best of my knowledge, there is no empirical evidence yet on the impact of such skills on older people's labour market dynamics. It is therefore important to fill this gap in the literature and to analyse the effects of CF on labour force participation. Since cognitive performance crucially depends on early-life circumstances, policy may be able to affect CF among future cohorts and, hence, their propensity to work in older age.

Understanding how CF affects older people's work decisions is also a starting point in assessing the economic value of initiatives such as 'skills for life' among older people. This initiative is aimed at improving adult literacy and numeracy skills and has been launched by the Department for Education and Skills (DfES) in November 2000.[1]

Until recently, good data on CF have rarely been available in surveys which also offer comprehensive information on socio-demographic characteristics and, in particular, employment. However, this has changed with the US Health and Retirement Study (HRS), which started in 1992 and of which currently eight waves are available, and, recently, with the introduction of the English Longitudinal Study of Ageing (ELSA) which I will use in this paper.

Most of the literature about the impact of CF on labour market outcomes focuses on

[1] Internet: `http://www.dfes.gov.uk/readwriteplus/`

the impact of schooling achievement on labour market entry. To my knowledge, there is no literature on older people. However, there are also a few papers and at least one book on the general working-age population.

Pryor and Schaffer (2000) used the Current Population Survey (CPS) and the 1992 National Adult Literacy Survey (NALS) to explore recent transformations of the US labour market. Among other things, they stress the role of cognitive skills, going beyond formal educational attainment, and their effects on labour market participation, occupational mobility, and wages. They argue that while educational credentials have become more and more wide-spread, functional literacy (literacy and numeracy with a particular emphasis on work-related aspects) has not grown equally fast, causing the wage differential between high-CF and low-CF jobs to increase further. They state that 'if functional literacy is one standard deviation higher than the mean, men and women have respectively a 3.5 and 7.2 percent greater probability of employment' (Pryor and Schaffer 2000: 38).

Cawley, Heckman, and Vytlacil (2001), as well as Heckman and Vytlacil (2001), use the National Longitudinal Survey of Youth 1979 (NLSY79) to study, for US men and women aged 15–37, whether the (log) wage premia for education and ability have risen over time. They measure ability by the Armed Services Vocational Aptitude Battery or ASVAB, which includes work-related and general cognitive skills. They report strong identification problems caused by the high correlation between education and ability in their sample but find evidence for an increase of the education/ability wage premium between 1980 and 1994.

Anger and Heineck (2006) use the German Socio-Economic Panel (GSOEP) to study German men and women aged 20–60 and the effects of CF (measured by speed of cognition and verbal fluency, which is measured by how many animal names the respondent can mention in a specific time period) on the unemployment probability and (log) earnings. Like Heckman and Vytlacil, they find that the effects of education and ability become statistically insignificant when an education-ability interaction term is included. Also, verbal fluency is found to be inseparable from education. Their results point towards a negative effect of CF on the unemployment probability, finding that an increase of the speed test score by one standard deviation reduces men's unemployment probability by 5% and women's by 3%. They also find a positive effect of CF on (log) earnings (increasing the speed test score by one standard deviation increases earnings by 7%).

Although these studies tend to focus on wages and earnings as labour market outcomes, I will focus on employment dynamics, for two reasons. First, the decline in labour force participation as people become older is more pronounced than the decline in average earnings in later life among those who remain in work.[2] Second, earnings inequality increases sharply over the life-cycle, mostly due to unobservables.[3] This implies that it is difficult to estimate satisfactory wage or earnings regressions for older people with a panel of only two waves as is currently the case for ELSA. I will, however, also report the effects of CF on earnings and wages in Appendix C to enable comparison with other studies.

I address the following three research questions in this paper:

1. Is there a relationship between CF and employment among older men and women in England?

2. If so, which measures of CF show particularly strong links?

3. Can we say anything about causality, i.e. does CF affect employment and not vice versa?

[2]Cross-sectionally, average labour income of men and women working full-time is only 6% lower at age 60 than at age 50. This could of course also be due to a selection effect, with those who would have low earnings in later life leaving the labour market earlier.

[3]See Deaton and Paxson (1994) for theoretical arguments as well as empirical evidence for Great Britain, the USA, and Taiwan.

2 How does cognitive functioning affect work?

In order to address these research questions, it is essential to decide on how to model the relationship between cognitive functioning and the work decision. Even when deciding to use a binary definition of 'work', the question remains whether to model (1) the effects of the *level* of CF on the probability of working or (2) the effects of *changes* in CF on the probabilities of transition out of employment and back to employment.

I model the effects of changes in CF on employment exit and entry probabilities, arguing that it is advantageous to employ approach (2). This is because it is a very strong assumption to say that people with lower CF are generally less likely to work. There are jobs with different requirements of CF, and somebody who loses a high-CF job due to a decline in CF may well still have a higher level of CF than somebody who had a low-CF job for his or her entire working life. Since it is difficult to measure the 'cognitive requirements' of a job, it would be difficult to obtain good estimates of the effects of the CF level on the probability to work. Estimating the effects of changes in CF on the probabilities to exit or enter work does not suffer from this problem.

It is possible to extend the focus on transitions (extensive margin) to an analysis of the change in working hours (intensive margin). I also present the results from this approach. However, it is not my preferred approach since I observe in the data that changes in employment patterns over the life-cycle are mostly due to changes on the extensive margin rather than due to changes on the intensive margin. Working hours remain highly stable among men aged 50–64 and women aged 50–59, with only a slight decline in median working hours among men who report non-zero hours, and only a slightly inverse U-shaped relationship for women who report non-zero hours.[4] Moreover, measurement error and missing values

[4]This empirical observation is true both cross-sectionally using ELSA as well as longitudinally using the BHPS. Banks and Smith (2006), using the BHPS, report similar findings, observing that, for men as well as for women, there is only a very slight reduction of working hours in the years before exiting work: 'The evidence suggests that, for the great majority of people, retirement is not a gradual process of labour market

are much more of a problem for measures of working hours than for a measure of whether somebody works or not. Therefore, employment exit and entry regressions can be expected to yield superior results compared to hours change regressions conditional on having worked in $t - 1$.

Another advantage of focusing on changes is that individual-specific fixed effects cancel. This advantage is emphasised by Disney et al. (2006) who, using the BHPS, estimate economic activity equations to evaluate which measures of health have the strongest predictive power. They estimate fixed-effects logit, logit, and linear fixed-effects models, arguing that the fixed-effects logit model is superior to the other two approaches since it eliminates person-specific effects which are found to make an important difference, and since it takes into account the binary dependent variable which the linear fixed-effects model does not. Even though I use probit models of changes rather than fixed-effects logit models, their argument carries over to my analysis.

Modelling the exit from and the entry into employment, and the change in working hours, also helps to alleviate a number of other problems. These are discussed later in this paper. First, however, I present the data and sample selection criteria used, with particular emphasis on CF and work.

3 Data and sample selection

3.1 The English Longitudinal Study of Ageing

ELSA is a survey of people aged 50 or older living in the household sector in England, and their partners regardless of their age (Taylor et al. 2004). The first ELSA wave included 12,100 respondents, approximately 11,500 men and women aged 50 plus and approximately 600 younger partners. Currently, data are available from the first two ELSA waves (2002

withdrawal, but instead involves a fairly abrupt transition from full-time employment to zero hours.'

and 2004).

3.2 Sample selection

I focus on the age group 50–70. This is due to the fact that it may be useful to look at a few more years beyond the state retirement pension age (65 for men, and 60 for women). Employment rates are very low beyond the age of 70 which is why, in line with Haardt (2007), I do not analyse what happens beyond that age.

Another sample selection issue is whether to include the self-employed in the analysis. It could be argued that the self-employment decision is governed by a different process than the employment decision. In particular, somebody who is self-employed may continue to work even though his or her level of CF is lower than necessary to make a living in that job. On the other hand, excluding the self-employed altogether implies that it becomes difficult to define meaningful at-risk groups for the exit from employment or the entry into employment. Furthermore, looking at the pooled data in my regression sample, almost one fifth of those who work are self-employed. This implies that excluding the self-employed would reduce sample size noticeably. This is particularly problematic when modelling entry to work since this event is quite rare in this age group.

Therefore, I decided to include the self-employed in my exit, entry, and hours change regressions. I do however exclude the self-employed from my wage, earnings, and wage change regressions in Appendix C since there is the problem of negative self-employment labour income. Note too that these regressions had markedly higher explanatory power when the self-employed were excluded. However, the key results with respect to CF held true also when they were included.

3.3 Cognitive functioning in ELSA

A key advantage of ELSA is that it collects a large amount of information specifically relevant to ageing, including highly detailed information on work, health, and pension saving. Among the information on CF are:

- Self-assessed memory performance (range 1–5)
- Self-assessed change in memory performance compared to two years ago (range 1–3)
- Date score (knowing the date and the day of the week) (range 0–4)
- Immediate recall (respondents are asked to repeat a ten-item word list) (range 0–10)
- Delayed recall (respondents are asked to repeat the same word list again later during the interview) (range 0–10)
- Verbal fluency (mentioning as many animal names as possible within one minute) (range 0–63)
- Prospective memory score (details below) (range 0–5)
- Numeracy (answering a number of simple mathematical questions) [wave 1 only] (range 0–6)
- Literacy (understanding simple texts such as instructions for medicine use) [wave 2 only] (range 0–3)

These variables are all collected in both waves, except for numeracy and literacy. The range of all CF variables, except verbal fluency, is implied by the questionnaire design. The prospective memory score is computed from the respondent's performance on the following task: 'At some point during the interview I will hand you this clipboard and a pencil.

(SHOW RESPONDENT THE CLIPBOARD). When I do I would like you to write your initials on the top left hand corner of the piece of paper attached to the clipboard.'

The US Health and Retirement Study (HRS) also includes a section on CF. Many items are very similar to those in ELSA (self-assessed memory performance, self-assessed change in memory performance, immediate and delayed recall, and numeracy). However, there are also some differences: in wave 1 (1992), the HRS included questions on the similarity of pairs of objects; the date score has only been included since wave 3 (1996); since wave 3, respondents have been asked to count backwards from 20; since wave 3, there have also been questions on factual knowledge (such as about the president and the vice-president of the USA), questions on functional knowledge,[5] and questions about the meaning of a number of words. However, a question on prospective memory has only been included in wave 8 (2006).[6] Moreover, the HRS does not include questions on verbal fluency or literacy. In that sense, the CF questions in ELSA are perhaps better suited to assess CF in an everyday context than those in the HRS.

As more ELSA waves become available, it will become easier to model changes over time. Currently, it is not possible to analyse *changes* in numeracy or literacy; this will require waves 3 and 4. I therefore do not use numeracy or literacy in my exit, entry, or hours change regressions. However, I will carry out robustness checks with the levels of these variables in Section 6.

One important advantage of the CF data in ELSA is that there are subjective as well as objective measures of CF. Objective measures of CF are subject to less measurement error and using them avoids problems of different perceptions of subjective CF questions across respondents. Some respondents may for instance answer the question about self-assessed memory performance compared to the population as a whole, others compared to people

[5]Such as 'What do people usually use to cut paper?'

[6]'I have a favor to ask you. I need to check something on my computer in a little while. Could you please remind me to check it in about five minutes?'

of their own age. I will therefore not use self-assessed CF in my analysis. It is important to keep in mind though that objective CF may be the result of past employment, an issue which I will address in the following section of this paper.

I analyse Cronbach's alpha to see how closely related the CF variables are with each other. This shows that only immediate and delayed recall can be meaningfully combined, with an alpha of 0.79, whereas the alphas for other pairs of CF variables are much lower. The same conclusion is obtained when computing the correlations of all pairs of CF variables (0.70 between immediate and delayed recall but much lower for all other combinations). This suggests that there are several underlying constructs of CF.

Even with many alphas being low, it is still useful to create an index of CF to reduce dimensionality and obtain a convenient summary measure of CF. Steel et al. (2004) and Huppert et al. (2006) use CF indices which are *ad hoc* combinations of the underlying CF variables, rescaled in a rather arbitrary way. My approach is slightly less arbitrary since I standardise the CF variables to have a mean of zero and a standard deviation of one and then add them up. I create two CF indices, a regular index which is based on the date score, immediate recall, delayed recall, verbal fluency (animal names), and the prospective memory score, and a second index which excludes the date score (since this variable is most likely to be influenced by whether somebody works or not).

Figure 2 shows the distribution of the CF index, broken down by whether a person is working full-time or not. 'Working full-time' in this context means working 16 or more hours a week. (I explain shortly why I chose a threshold of 16 hours per week. Different thresholds do not affect the argument.) One can see only a very slight difference between the two panels of the figure – the mean is slightly higher for those who work and the variance slightly lower. According to this figure, there is little evidence for a difference in CF depending on whether somebody works full-time or not.

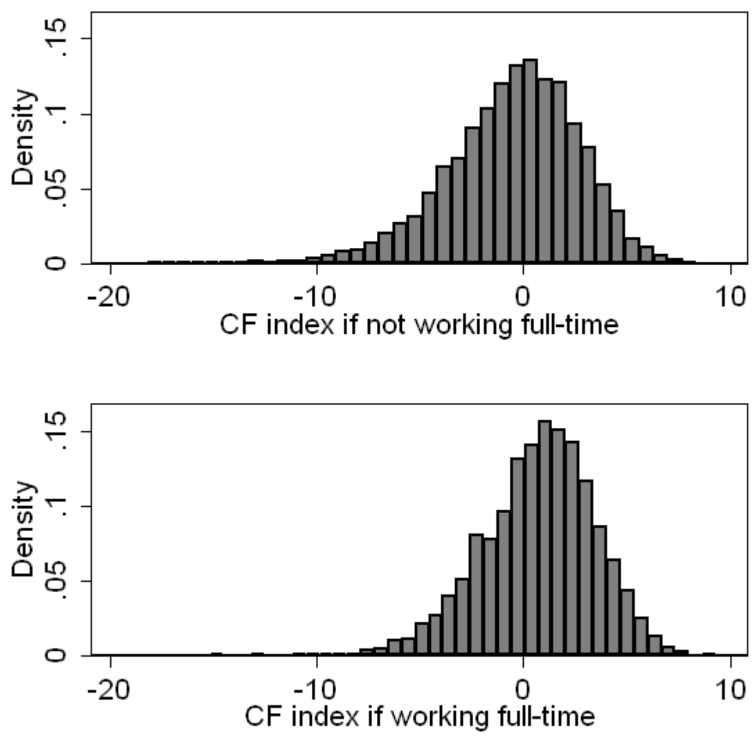

Figure 2: CF index by whether respondent is working full-time or not (source: own analysis using ELSA data, pooled data).

Schaie and Strother (1968) showed that notions of ‘cognitive decline’ over age may be due to cohort effects rather than due to longitudinal cognitive decline for a given person. Even though my two observations for each respondent are only two years apart, it is interesting to look at changes in the CF variables and how mean and median changes vary by age group. Table 1 shows that there is less decline than may have been suspected. For prospective memory and delayed recall, even in the oldest age group (which I do not include in my regression analysis) neither the mean nor the median is negative. The only CF variable for which the mean and median change are negative in the oldest age group is verbal fluency. For the remaining two CF variables, the date score and immediate recall, the mean change is negative in the oldest age group but the median change still equals zero. This confirms the early results of Schaie and Strother (1968) for the USA and is an interesting finding in its own right.

	50–54	55–59	60–64	65–69	70 plus
D.(date score), mean	0.0090	0.0238	0.0604	0.0445	–0.0871
D.(date score), median	0	0	0	0	0
D.(immediate recall), mean	0.1419	0.1389	0.0424	0.0569	–0.0277
D.(immediate recall), median	0	0	0	0	0
D.(verbal fluency), mean	0.0423	0.3544	0.1859	–0.0044	–0.4391
D.(verbal fluency), median	0	0	0	0	–1
D.(prospective memory), mean	0.2897	0.2660	0.0797	0.2293	0.0117
D.(prospective memory), median	0	0	0	0	0
D.(delayed recall), mean	0.2097	0.1941	0.1402	0.1421	0.0318
D.(delayed recall), median	0	0	0	0	0
D.(CF index), mean	0.3512	0.4030	0.2135	0.2797	–0.1816
D.(CF index), median	0.3199	0.4191	0.1920	0.3378	–0.0637
D.(CF index w/o date score), mean	0.3659	0.4144	0.1780	0.2541	0.0698
D.(CF index w/o date score), median	0.2943	0.4691	0.1578	0.3115	0.0369

Table 1: Means and medians of the change in the CF variables by age group.

It is important not to interpret Table 1 as saying that there is *no* longitudinal decline. The table only presents means and medians, and there is of course a lot of variation in the tails of the distribution. This variation will be crucial to identify the effects of CF changes in my models.

3.4 Potential endogeneity of cognitive functioning

A potential problem concerning the use of CF as an explanatory variable is that it may be endogenous. Banks (2006: 299) emphasises that not only is the impact of CF on employment important, but also the reverse impact of employment on CF. Implicitly, my specification, with employment outcomes on the left-hand side and CF on the right-hand side, is based on the former direction rather than on the latter.

If being in work helps to build and maintain CF, an endogeneity bias may occur. This means that my measures of CF are positively correlated with the error term, leading to an upward bias of the coefficients of the CF variables, i.e. an overstatement of the estimated effects of CF on work (see Wooldridge 2002: 62). However, it is difficult to think of plausible instruments that affect CF but do not have direct effects on whether somebody works or not.

To see whether the data point towards such an endogeneity bias, I run two simple probit regressions explaining whether somebody works full-time or not in wave 2 by the level of CF and a full set of controls.[7] The first of these regressions uses contemporaneous CF whereas the second uses lagged CF. The results of this comparison are presented in Table 2.

There are important differences depending on whether contemporaneous or lagged CF variables are used. In particular, the absolute size of many coefficients decreases when using lagged CF variables. These results are consistent with our expectations in the case of endogenous CF. They suggest that linking changes in CF to exits from and entries to employment may be more fruitful than linking levels of CF to the probability of working at a point in time.

[7]This table uses a threshold of 16 hours per week as in my main analysis. Those with a '1' work 16 or more hours, those with a '0' work less than 16 hours or do not work at all. However, the key findings are the same when using a different threshold, such as 10 hours per week or 22 weeks per annum.

	$\text{work}_{t=2} = f(\text{CF}_{t=2})$	$\text{work}_{t=2} = f(\text{CF}_{t=1})$
Men		
Date score	0.0423*	0.0362
Immediate recall	–0.0043	0.0012
Verbal fluency	0.0019	0.0011
Prospective memory	–0.0033	0.0049
Delayed recall	–0.0011	–0.0021
Women		
Date score	0.0620**	0.0421*
Immediate recall	0.0151**	0.0091
Verbal fluency	–0.0005	–0.0016
Prospective memory	0.0193***	0.0127**
Delayed recall	–0.0176***	–0.0054

Table 2: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the probit model, comparing using (a) contemporaneous versus (b) lagged CF variables. Full controls included. Full results for (b) in Table 1, Appendix A.

I would argue that CF is the result of an accumulation of cognitive capital over the life-course. There is now some evidence that the most important part of this accumulation process takes place during childhood, and that the stock of CF as well as its development during adulthood crucially depend on child development (see for instance Heckman 2000). Similarly, Simpson (1980: 306) stressed that empirical findings on whether work has short-run effects on CF are rather mixed.

If the observations of Heckman and Simpson are true, CF will not instantaneously react to changes in labour market status, working hours, or occupation.[8] However, there may well be instantaneous effects of changes in CF on employment outcomes, particularly when considering large sudden declines.

[8]The only CF variable for which such an effect is plausible is the date score; as mentioned previously, I will run all regressions twice, once with and once without this variable.

3.5 How to define being in work

I define somebody as working if he or she works at least 16 hours per week, and as not working if he or she works less than 16 hours per week, including zero hours due to unemployment, self-reported retirement, or any other reason.

Traditionally, most research in labour economics has analysed *economic activity* (also referred to as labour force participation) rather than *work*. This is because economic activity is a decision of the economic agent alone, whereas whether somebody will actually work or not is also subject to factors beyond his or her control, e.g. labour demand.

I would argue that, in my context, it is better to model work than economic activity, for at least three reasons. First, if we are interested in CF as a potential factor through which to finance population ageing, work rather than economic activity matters. Second, work can be more objectively measured than economic activity (because of the problems in defining and measuring job search). Third, the unemployment rate among those aged 50 or older is very low which means that differences between the two approaches can be expected to be minor. In principle, it may be worthwhile to model both processes. However, this would require a larger sample for precise estimates, in particular a sample with more people who are economically active yet do not work, i.e. containing more unemployed.

It is also important to define 'work' precisely. There are at least three different approaches:

1. Self-reported work status
2. A specific minimum number of hours per week
3. A specific minimum number of weeks per annum

Measures of self-reported work status are subject to well-known problems (such as ex-post rationalisation), and most of the literature regards all individuals with a positive number of weekly working hours as working (e.g. Harkness 1993). However, imposing a certain minimum amount of hours is useful in my analysis. In the distribution of weekly working hours in ELSA (pooled data from both waves), 15 hours per week is the lowest major peak in the data. However, using 'working 16 or more hours per week' to define work status may be more appropriate as this is the threshold commonly used to distinguish between part-time and full-time work for the purpose of benefit receipt in the UK.[9] Using 16 hours per week as the lower bound classifies only 11% of those who call themselves working as not working (i.e. 11% of those who call themselves working work 15 or less hours per week). I therefore use 16 hours per week as my minimum threshold.

I checked whether the results of my regression analysis were robust to the choice of cut-off point and to the choice of weekly working hours compared to one of the other two approaches just mentioned. Fortunately, the key results of my regressions remained qualitatively unchanged regardless of the approach and cut-off point chosen. The coefficients of the CF variables remain virtually unchanged.

		t+1			
		0	1	Missing	Total
t	0	63.28	3.26	33.46	100.00
	1	17.27	63.60	19.13	100.00
	Total	43.55	29.13	27.32	100.00

Table 3: Work transition matrix, row percentages.

Table 3 shows the transition matrix between work, non-work, and attrition when adopting the '16 hours' definition. The risk of panel attrition is markedly higher for those who did not work in wave 1 than for those who did. For this reason, I will also address panel attrition in my analysis.

[9] More specifically, this threshold is used for the following benefits: Jobseeker's Allowance, contributory Jobseeker's Allowance, Job Grant, Income Support, and Working Tax Credit. See Phillips and Sibieta (2006) for further details.

4 Empirical implementation

4.1 Econometric models

The two main econometric models I use are: an employment exit/entry regression and an hours change regression. I will start with the exit and entry models which are essentially identical to each other in structure. Suppose that the latent propensity of individual i to exit from or enter into work between $t = 1$ and $t = 2$ is given by

$$p_i^* = \alpha + \beta \Delta c_i + \gamma h_{i,t=1} + \delta \mathbf{x_{i,t=1}} + \epsilon_i, \tag{1}$$

where Δc_i represents the change in cognitive functioning, h_i physical health, $\mathbf{x_i}$ is a vector of other (exogenous) variables, and ϵ_i an error term. We do not observe the latent propensity p_i^*, only the outcome.

In the case of exit from work, an observed outcome of '1' means that somebody worked 16 or more hours per week in $t = 1$ and less than 16 hours (including zero hours) in $t = 2$, whereas a value of '0' means that somebody worked 16 or more hours per week in both $t - 1$ and t.

In the case of entry to work, a '1' means that somebody worked less than 16 hours (including zero hours) per week in $t = 1$ and 16 or more hours per week in $t = 2$, and a '0' means that somebody worked less than 16 hours (including zero hours) per week in both $t = 1$ and $t = 2$.

As mentioned before, c_i may include all measures of cognitive functioning as available in ELSA, and h_i may include information about functional limitations or medical conditions. Finally, $\mathbf{x_i}$ will include control variables such as age, education, marital status, housing tenure, ethnicity, occupation, or information on other people living in the household.

Even though c_i appears in changes, h_i and $\mathbf{x_i}$ are included in levels. For most variables in h_i and $\mathbf{x_i}$, there are arguments both for including them in changes and for including them in levels. In the survival analysis literature, it is common to explain conditional event probabilities by variables measured in levels, whereas in the dynamic panel literature it is common to explain changes in the dependent variable by changes in the explanatory variables. I include the levels of the non-CF explanatory variables as in the survival analysis literature. This is the simplest approach and also minimises problems with missing values.

These regressions are estimated using probit models which are run separately by sex to allow men and women to have different parameter vectors. I report marginal effects of the probit coefficients evaluated at the means of the explanatory variables. (For dummy variables, I report the effects of a discrete change from 0 to 1.)

Let us now turn to modelling the change in working hours in a standard OLS framework:

$$\Delta L_i = \alpha + \beta \Delta c_i + \gamma h_i + \delta x_i + \epsilon, \tag{2}$$

where L represents labour supply measured in weekly hours. The right-hand side of equation 2 is equivalent to that of equation 1. The hours change models are estimated for respondents regardless of their working hours in both waves.

Among these models, the exit and entry regressions are my preferred focus from a substantive and a methodological point of view, as detailed in Section 2.

4.2 Controlling for sample selection

There are three forms of sample selection which need consideration.

First, there is the problem of panel attrition. CF scores in wave 1 are systematically lower for those who drop out than for those who continue to participate in wave 2. This is true even when the sample was limited to respondents aged 50–54, implying that sample dropout is unlikely to be linked to death or severe health problems.

If the process governing panel attrition and the process governing the work decision are linked, my estimates of the effects of CF on work may be biased. Therefore, I jointly model the transition (or hours change) equation and the panel retention equation. I do so by using Heckman probit models (for the exit from and the entry into work) and Heckman selection models (for the change in working hours).

I use four additional regressors in the selection model that are excluded from the transition or hours change equation, all measured at the wave 1 interview: (1) whether respondents agreed to provide an additional contact address through which to get in touch with them, (2) whether respondents agreed to record linkage for economic and health data, (3) whether respondents consulted their documents during the ELSA section on income and assets, and (4) the interviewer's assessment of the reliability of the respondent's answers in this section. I argue that these variables have a direct impact on panel attrition but not on labour force participation.

The second form of sample selection is that, for the wage and earnings regressions presented in Appendix C, we observe labour income only for those who work. This may cause a selection bias. In many studies on the general working-age population, the number of dependent children is used as the instrument for the selection into work. However, this is not appropriate in my context. The children of the respondents in my sample will in most cases already be too old to need high levels of supervision. However, it may well be that the respondents are providing care for their spouse or for their parents. I therefore use information on the hours spent giving care to others during the last week as the instrument for selection into work. This variable includes giving care to one's children, spouse, or parents. The implicit assumption is that this variable only has direct effects on selection into work, not on the wage rate or earnings. For earnings, this assumption might be challenged whereas for the wage rate it is quite convincing.

The two selection problems may appear jointly. In regressions explaining the *change* in the wage rate, respondents are only included in the regression sample if they work *and* survive to the second wave of ELSA. However, I would argue that the work selection bias is limited to the wage *level* and does not affect the wage change. Moreover, modelling such joint selection would only complicate the analysis further. I therefore do not consider it in this paper.

4.3 Issues concerning the explanatory variables

There are also three potential problems concerning the explanatory variables.

4.3.1 Cognitive functioning and education

The first issue is a potentially high correlation between CF and educational attainment which may cause identification problems. As mentioned in the introduction to this paper, Cawley, Heckman, and Vytlacil (2001) as well as Heckman and Vytlacil (2001) show that these two variables are highly correlated in the USA. For instance, they do not have any college graduates from the lowest CF quartile in their data. Many cells in their education-CF matrix are empty. Therefore, they argue that the effects of education and CF cannot be separately identified without strong parametric assumptions.

To investigate whether the same problem exists in my UK data, I cross-tabulated education by CF quartile group, see Table 4. A substantial proportion of university graduates are in the lowest CF quartile. There is a positive association between education and CF, but it is much weaker than in the US data of Heckman and Vytlacil. This association is slightly higher for men than for women.

Their problem may not be an issue here because my measure of CF consists of measures of memory and verbal fluency whereas Heckman and Vytlacil's CF measure also includes factors that are more likely to be closely related to education, including numeracy and literacy. These were not included in the CF index used to compute Table 4 since I do not use these variables in my regression analysis, except for some robustness checks. Even though the association of numeracy and literacy with education is indeed somewhat higher than that of other CF variables with education, I never observe an association as high as reported by Heckman and Vytlacil. I am therefore more confident of being able to separate the effects of education and CF.

	1st	2nd	3rd	4th	Total
Degree	8.68	16.99	29.38	44.96	100.00
Other HE	16.06	22.83	27.11	34.00	100.00
A levels	13.69	23.30	27.57	35.44	100.00
O levels	15.85	24.31	30.22	29.63	100.00
NVQ1/CSE	36.94	30.93	19.59	12.54	100.00
Other	25.45	28.78	26.26	19.51	100.00
None	41.45	28.31	19.78	10.47	100.00

Table 4: Cross-tabulation of the quartile group of the CF index by educational qualification, row percentages (pooled data, both sexes, $n = 13,740$).

Cross-tabulation of the quartile group of the *change* in the CF index by education helps us see whether this potential problem is alleviated further by differencing. Table 5 shows that there is virtually no association between these two variables. In other words, education is associated with the level of CF, but not with changes in CF.

	1st	2nd	3rd	4th	Total
Degree	24.55	26.96	23.46	25.03	100.00
Other HE	23.75	26.56	26.82	22.86	100.00
A levels	22.10	27.01	23.66	27.23	100.00
O levels	23.87	26.22	26.31	23.61	100.00
NVQ1/CSE	30.60	23.28	24.57	21.55	100.00
Other	22.27	25.17	25.61	26.95	100.00
None	27.09	22.32	24.34	26.25	100.00

Table 5: Cross-tabulation of the quartile group of the change in the CF index by educational qualification, row percentages (pooled data, both sexes, $n = 5,666$).

4.3.2 Cognitive functioning and age

The second issue is: should age be included in $\mathbf{x}_{i,t=1}$, the vector of explanatory variables? CF and age, like CF and education, may be highly correlated and, moreover, may measure similar things.

The correlation between age and CF is highest for immediate recall and delayed recall (around –0.40 in both cases). Interestingly, the correlation between age and self-assessed memory performance (–0.05) is much lower than that of age and any objective CF measure.

Age alone explains up to 18% of the variation in each CF variable (as measured by the adjusted R-squared in an OLS regression). The explanatory power is strongest for the immediate recall variable.

	1st	2nd	3rd	4th	Total
50–54	16.42	22.02	27.58	33.99	100.00
55–59	19.65	24.35	25.90	30.10	100.00
60–64	26.94	26.72	25.88	20.46	100.00
65–70	36.48	26.74	21.81	14.97	100.00

Table 6: Cross-tabulation of the quartile group of the CF index by age group, row percentages (pooled data, both sexes, $n = 13,798$).

Table 6 shows that even though there is an association between CF and age, there is certainly no danger of empty cells.

	1st	2nd	3rd	4th	Total
50–54	25.88	23.99	22.99	27.14	100.00
55–59	22.68	25.70	25.81	25.81	100.00
60–64	26.22	25.31	25.10	23.37	100.00
65–70	26.10	24.43	24.98	24.49	100.00

Table 7: Cross-tabulation of the quartile group of the change in the CF index by age group, row percentages (pooled data, both sexes, $n = 5,668$).

These results all consider age cross-sectionally. As shown earlier, the correlation of longitudinal decline in CF with age is much lower than cross-sectional data may suggest. This is also shown in Table 7 which cross-tabulates the quartile group of the change in the CF index by age group. It can be seen that the association is very small.

Another argument for including age in addition to CF in the work regressions is that age may also measure many things other than a physiological ageing effect, such as changing preferences for leisure or changing attitudes towards work. After experimenting with different specifications of age and with excluding age, I decided to use an age spline in all the regressions that I report. When age was excluded, the marginal effects with respect to the CF variables were qualitatively similar (and similar with respect to statistical significance), but larger. This is what we would expect to see given the correlation between age and CF.

4.3.3 Endogeneity of physical health

Third, there is the well-known problem of the potential endogeneity of physical health to work, or, more generally, its mismeasurement.[10]

It is advantageous that ELSA does not only collect information on self-assessed health, but also a number of more objective measures of physical health. There is, for instance, plenty of information on functional limitations. In this paper, I use a dummy variable for functional limitations since such an approach is parsimonious yet powerful.

Lambrinos (1981), using the US 1972 Social Security Survey of Disabled and Nondisabled Adults (SDNA), examined the effects of different specifications of health in labour supply models, arguing that specification is important, and that using information on functional limitations is a simple way of reducing endogeneity bias.

In a similar vein, Stern (1989), using the US 1978 Survey of Disability and Work (SDW), modelled the labour force participation decision and the decision whether to report a disability or not using a simultaneous equations probit model. He found that the health limitations variable was particularly powerful in explaining the 'true' effect of disability.

[10] See Bound (1991) for a discussion.

I conclude from these papers that using information on functional limitations is a simple but effective measure to prevent endogeneity bias with respect to physical health. Such a variable is readily available in ELSA, and using it helps to avoid making the modelling structure even more complicated or adding even more groups of explanatory variables.

4.4 Explanatory variables

I use (changes in) all objective **CF variables** that are available in both waves, i.e. the date score, immediate recall, delayed recall, verbal fluency (animal names), and the prospective memory score.

As mentioned before, the date score may be affected by whether somebody works or not. Therefore, I run all regressions twice, one with and once without the date score. I also create two indices of CF, one which includes the date score and one which does not.

To carry out robustness checks to see whether only very low or very high CF has an impact on labour market dynamics, I also run all regressions using dummy variables for the decile group of the two CF indices.

There are a number of controls, included in the $\mathbf{x_i}$ vector.[11] Information on **wealth** is the first of them. Since the house or flat in which somebody lives may have a different effect than other wealth (because of its consumption value and limited liquidity), I include net housing wealth (current value of the main home minus any outstanding debt on it) and net non-housing wealth (everything else) separately. Since these variables can take negative as well as positive values, I enter the inverse hyperbolic sine of them in the regressions, denoted by $\sinh^{-1}(\cdot)$. This ensures that the weight attached to extreme values of wealth is reduced and provides a better fit for my data than linear or other non-linear specifications.[12]

[11] In the employment exit, employment entry, and hours change regressions, all control variables are measured at wave 1.

[12] Burbidge et al. (1988) discuss the advantages of the inverse hyperbolic sine compared to an extended Box-Cox transformation.

The interpretation of a coefficient of a variable that has been transformed using the inverse hyperbolic sine is very similar to that of a lagged variable, as long as the underlying values are not too close to zero.[13]

After having experimented with different specifications of **age**, I settled for an age spline with five-year intervals. This ensures reasonable flexibility whilst making sure that there are not too many parameters which have to be estimated.

In terms of measures of **physical health**, I use a dummy variable for health limitations as previously mentioned.

For **education**, I use seven categories: degree, other higher education, A levels, O levels, NVQ1/CSE, other qualification, and no qualification (base category).

I also include a dummy variable for **marital status** which equals 1 for married individuals (who may or may not be in their first marriage) and 0 for everybody else (single, divorced, separated, or widowed).

Since **housing tenure** is an important measure not only of wealth but also of geographical mobility and status, I include two dummy variables for this domain: one for outright owners and one for owners with a current loan or mortgage. The base category includes everybody else, i.e. mainly renters (tenants of local authorities, housing association tenants, or private renters).

As far as information on **occupation** is concerned, I merge the professional and managerial/technical occupational groups into a single category. I also merge the partly skilled and unskilled groups. This is due to the fact that there are fewer observations in the groups professional and partly skilled than in the other occupational groups, causing collinearity problems in the regression analysis, particularly for the entry regressions. This leaves four occupational groups:

[13] In my data, there are only very few observations of wealth with a small absolute value, apart from those that equal zero.

- Professional, managerial, and technical
- Skilled non-manual
- Skilled manual
- Partly skilled and unskilled (includes those who never worked)

The last of these four is the base category.

Finally, I also use **household size**, i.e. the total number of people living in the household. This gives an indication of how many others in the household may need to be supported by those of working age.

There are a number of variables which I could not use. I had to exclude information on whether the respondent was born in the UK or elsewhere, because fewer than 2% of the sample were born outside of the UK. Data about the region of residence are not part of the public ELSA release for reasons of confidentiality. For the same reason, and because I analyse only one pair of waves, I cannot use the unemployment rate.[14]

I do not include the number of children, which is often used in related analyses for the general working-age population. As mentioned previously, this is because having to provide childcare is much less of an issue for my age group.

5 Discussion of the estimates

5.1 Exit from work

The estimates from the exit probit regressions are shown in Tables 8 for men and 9 for women. As all the following tables, these two tables have four columns. The first column reports the estimates based on all five individual CF variables, the second column, the estimates when

[14]The unemployment rate would take the same value for everybody.

excluding the date score, the third column the estimates when using the full CF index, and the fourth column the estimates when using a CF index which has been computed without the information from the date score. As mentioned in Section 4.1, I report marginal effects evaluated at the means of the explanatory variables, except for dummy variables for which I report the effects of a discrete change from 0 to 1.

A quick look at Table 8 shows that the results are robust to the choice of CF variables. Men's exit from the labour market is associated with wealth, age, health, and housing tenure.

There are strong non-linear age effects. Those men who are still in work at ages 55–59 have lower exit rates than comparable men aged 50–54. This could be attributed to selection on unobservables—those with high ability remain in work during their early 50s whereas those with low ability are more likely to lose their job at this age. Another interesting selection effect can be observed for men beyond state pension age. Their exit rates are markedly lower than for those aged 60–64, and decline up to age 70. These are men who are highly attached to the labour market and therefore remain in work until an old age. Approximately 42% of men working beyond state pension age are self-employed. I suspect that the age trend would be monotonic if I had been able to include a variable on past employment experience as in Haardt (2007).

The effects of net non-housing wealth are much smaller than those of net housing wealth. The net housing wealth effect must of course be interpreted jointly with the coefficients of housing tenure (the tenure effect). For outright owners with a net housing wealth above approximately £90,000, the wealth effect is larger than the tenure effect, implying that these men are more likely to exit the labour market than other men. However, for outright owners with a net housing wealth below this threshold, the opposite is true. For owners with a current loan or mortgage, net housing wealth would have to equal at least £1.1m for the wealth effect to exceed the tenure effect; in other words, for virtually all owners with a current loan or mortgage, the overall effect of home ownership on the exit probability is still negative.

Finally, men with a health limitation are almost ten percentage points more likely to exit work between waves 1 and 2. On average, their exit probability is more than 50% higher than that of comparable men without such a health limitation.

There are no statistically significant effects of education, marital status, occupation, or household size (at the 10% level or lower). However, most coefficients are of the expected sign.

This leads to the estimates of key interest: the CF ones. No CF variable has a statistically significant effect on the predicted probability of working men to exit the labour market as defined earlier on.

For women, the picture differs slightly: see Table 9. There are no effects of wealth and housing tenure; these appear to operate for men only. An age effect is only visible for the five years prior to women's state pension age. The impact of a health limitation is smaller than for men, both in terms of percentage points as well as when related to the observed exit probability which is higher for women than for men.

By contrast with men, there are statistically significant education effects for women. Women with a degree or with 'other' qualifications are much less likely to exit than comparable women from another education group.

In terms of the CF variables, the coefficient of the date score is larger than for men whereas the other coefficients tend to be smaller than for men. As for men, no CF marginal effect is statistically significant at the 10% level.

5.2 Entry into work

Estimates from the entry regressions are shown in Tables 10 and 11. A potential problem with these regressions is the low number of events: note the small observed average entry probability. This leads to only a few marginal effects being statistically significant.

However, there are some interesting results. For men (Table 10), only age, physical health, and occupation have statistically significant associations with the entry into work. Note that the dummy variable for 'other' educational qualifications was dropped because nobody in the at-risk group for men's entry regressions was in this category.

The age effect is non-linear, though from age 60 onwards, there is a near-linear decline in the effect of age on the entry probability.

Men with a health limitation and/or those who last worked in a high-grade occupation have a lower probability of entering work than other men. The result for occupation may arise because their exit was due to choice rather than redundancy.

No other explanatory variables have statistically significant effects on men's entry probability. Interestingly, many CF variables, including the CF indices, have consistently negative, though not statistically significant, effects on the entry probability. Again, this might be the result of voluntary exit among high-CF men and involuntary exit among low-CF men, though this is not substantiated by my exit regressions.

For women, shown in Table 11, entry to work is even less common. This is consistent with the results from Haardt (2007). Only age and physical health have statistically significant effects. The effect of physical health is negligible, but this may be a lower bound to the real effect (Bound 1991).

5.3 Change in working hours

The estimates of the hours change regressions are shown in Tables 12 and 13. The (adjusted) R-squared for each regression is very low. Hardly any of the variance in the change in working hours can be explained by the explanatory variables. The effect sizes in terms of the predicted hours changes are usually small. However, the key result that the CF variables are not statistically significant is consistent with the results of my exit and entry regressions.

5.4 Some remarks on panel attrition

I controlled for panel attrition using Heckman probit models (for exit and entry) or standard Heckman selection models (for the change in working hours). For the exit and entry regressions, ρ was never statistically significant, implying that more efficient estimates can be derived by estimating these regressions separately rather than jointly with the panel attrition equation. For the hours change regressions, ρ is statistically significant, large, and negative, implying that those whose unobservables make them more likely to be retained in the panel have a smaller hours change than predicted by observables. However, the conclusion that the change in CF is not associated with the change in working hours remains unchanged when controlling for panel attrition. Full results of all selection models can be found in Appendix B.

6 Some further robustness checks

Even though there is substantial variation in most of the CF variables, it could still be that measurement error is driving the results since changes in CF are small for a considerable proportion of the sample. Therefore, I also use dummy variables for the decile groups of the CF index, either with or without the date score, as explanatory variables. However, my results also prevail when doing so. In other words, not even having very low or very high CF is associated with my dependent variables.

One interesting question is whether the relationship between CF and work changed over time. It is only possible to address this using the model which links the contemporaneous CF level to the probability of working since only two waves of data are available. I investigated this hypothesis by interacting CF with wave and found that the impact of CF on participation did not change between 2002 and 2004.

Heckman and Vytlacil (2001) found that only the interaction of education and CF can be identified, not their separate effects. As discussed earlier on, this is because CF and education are highly correlated in their US data, which is not true in my UK data. When I included such an interaction term in my models, the interaction was hardly ever statistically significant. Also, the effect of CF did not change significantly when estimating the models separately by education (or occupation, or education-occupation) group, which is another sign that I do not share the problem of Heckman and Vytlacil (2001). Of course, this was only possible for the biggest groups because of sample size limitations. In any case, the difficulties of interpreting the coefficients of interaction terms in binary regression models (Ai and Norton 2003) make it more appealing to refrain from using such interaction terms too often.

One potential criticism of my analysis is that I focused mostly on the effects of *memory* (and verbal fluency) on work outcomes whereas earlier studies on the general working-age population focused on functional literacy. Numeracy and literacy may have strong effects on labour market outcomes. I excluded these variables since they are only available in one single wave. However, it is possible to analyse the relationship between wave 1 numeracy and the probability of working at wave 1 or wave 2, or the exit and entry probabilities, and the relationship between wave 2 literacy and the probability to work in wave 2. When I ran those regressions, no statistically significant impact of literacy or numeracy on labour force participation was revealed. This corroborates my key finding that CF does not appear to influence labour market dynamics among older people in the UK.[15]

7 Summary and conclusions

As Banks (2006) writes, not much research has been done on cognition and work among elderly people. This paper is one of the first such studies.

[15] I did however find statistically significant effects of numeracy on the (log) wage rate. See Appendix C for details.

In summary, there are no effects of the change in CF on the exit from work, the entry into work, or the change in working hours.

There are a number of conclusions which can be drawn from this research, with reference to the three research questions stated in the introduction to this paper. First, a statistically significant link between CF and labour market outcomes is only found in static models for women which link the level of CF to the probability of working (see Table 2, or Appendix A for full results). There is no statistically significant link between CF and employment in dynamic models. Second, the static link is present only for the date score and the prospective memory score, where the former is highly likely to be endogenous. Third, the fact that the link disappears in models of changes implies that it is likely to be caused by a joint process rather than by CF affecting work. In other words, it is likely that CF and work are only correlated (and only slightly so, and only for women), but that there is no causal connection between the two.

This absence of effects is perhaps surprising compared to my expectations before embarking on this research.

My results are not driven by my focus on measures of memory and verbal fluency. When the lagged numeracy score or the contemporaneous literacy score were included in my regressions, there were no statistically significant effects either. When the third ELSA wave is released, I will be able to update my analysis including the change in the numeracy score between 2002 and 2006.

This is not to say that CF has no effects on employment. There are a number of reasons why my results could be reconciled with the presence of such effects. For instance, it may be that the employment change takes place later than within a two-year interval, implying that a model including lagged differences of CF would be necessary. To check this would require more ELSA waves. It could also be that 'normal' CF decline is accepted by employers in an implicit contract framework. In other words, employers may be aware that CF decline is more likely to occur as an employee grows older and may, for instance, assign such employees to different tasks. However, since I do not even observe effects for the lowest decile groups of CF change, this alone is unlikely to be the reason for my results.

Avenues for future research include finding out more about differences by occupational groups, both about the impact of CF on occupational choice as well as about the observed CF requirements of different jobs. As more ELSA waves become available, I will be able to test whether lagged CF changes are associated with labour market outcomes.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0201*	0.0201*	0.0202*	0.0202*
$\sinh^{-1}$(Other wealth)	0.0039**	0.0039**	0.0039**	0.0039**
Age spline (50–54)	0.0296**	0.0296**	0.0298**	0.0298**
Age spline (55–59)	0.0125*	0.0126*	0.0126*	0.0126*
Age spline (60–64)	0.0521***	0.0521***	0.0522***	0.0522***
Age spline (65–70)	−0.0598***	−0.0601***	−0.0600***	−0.0602***
Health limitation	0.0969***	0.0967***	0.0961***	0.0962***
Education = degree	0.0140	0.0139	0.0117	0.0117
Education = other HE	−0.0046	−0.0046	−0.0043	−0.0043
Education = A levels	−0.0311	−0.0314	−0.0313	−0.0311
Education = O levels	−0.0116	−0.0119	−0.0109	−0.0108
Education = NVQ1/CSE	−0.0082	−0.0089	−0.0060	−0.0061
Education = other	0.0091	0.0093	0.0088	0.0091
Married	−0.0146	−0.0145	−0.0157	−0.0156
Outright owners	−0.2138**	−0.2133**	−0.2143**	−0.2145**
Owners with mg/loan	−0.3036**	−0.3030**	−0.3041**	−0.3044**
Occ = prof/man/tech	−0.0114	−0.0116	−0.0107	−0.0107
Occ = non-man skilled	0.0120	0.0114	0.0119	0.0120
Occ = manual skilled	−0.0190	−0.0190	−0.0192	−0.0191
Household size	−0.0135	−0.0133	−0.0125	−0.0125
D.(Date score)	0.0053			
D.(Immediate recall)	0.0045	0.0045		
D.(Verbal fluency)	−0.0007	−0.0006		
D.(Prospective memory)	−0.0008	−0.0008		
D.(Delayed recall)	−0.0030	−0.0030		
D.(CF index)			0.0001	
D.(CF index w/o date)				−0.0004
Number of obs.	1,459	1,459	1,459	1,459
Log likelihood	−590.1124	−590.171	−590.6019	−590.5965
Observed P	0.1851	0.1851	0.1851	0.1851

Table 8: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the exit probit model for men.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	−0.0034	−0.0035	−0.0033	−0.0034
$\sinh^{-1}$(Other wealth)	0.0032	0.0032	0.0032	0.0032
Age spline (50–54)	0.0047	0.0046	0.0046	0.0045
Age spline (55–59)	0.0661***	0.0659***	0.0657***	0.0659***
Age spline (60–64)	0.0145	0.0140	0.0141	0.0140
Age spline (65–70)	−0.0279	−0.0275	−0.0275	−0.0274
Health limitation	0.0750**	0.0738**	0.0744**	0.0746**
Education = degree	−0.0963**	−0.0948**	−0.0948**	−0.0943**
Education = other HE	0.0038	0.0069	0.0074	0.0078
Education = A levels	0.0174	0.0183	0.0193	0.0190
Education = O levels	−0.0160	−0.0156	−0.0157	−0.0155
Education = NVQ1/CSE	0.0157	0.0213	0.0197	0.0212
Education = other	−0.0881**	−0.0863**	−0.0849**	−0.0852**
Married	0.0398	0.0408	0.0406	0.0410
Outright owners	0.0952	0.0977	0.0965	0.0966
Owners with mg/loan	0.0436	0.0455	0.0439	0.0441
Occ = prof/man/tech	−0.0429	−0.0432	−0.0432	−0.0430
Occ = non-man skilled	−0.0517	−0.0517	−0.0514	−0.0515
Occ = manual skilled	0.0294	0.0289	0.0303	0.0293
Household size	−0.0191	−0.0195	−0.0193	−0.0194
D.(Date score)	−0.0282			
D.(Immediate recall)	−0.0001	−0.0003		
D.(Verbal fluency)	−0.0008	−0.0009		
D.(Prospective memory)	0.0003	0.0004		
D.(Delayed recall)	0.0006	0.0007		
D.(CF index)			−0.0023	
D.(CF index w/o date)				−0.0006
Number of obs.	1,216	1,216	1,216	1,216
Log likelihood	−563.9808	−564.5521	−564.5434	−564.645
Observed P	0.2401	0.2401	0.2401	0.2401

Table 9: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the exit probit model for women.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0025	0.0025	0.0026	0.0025
$\sinh^{-1}$(Other wealth)	0.0004	0.0003	0.0003	0.0003
Age spline (50–54)	0.0023	0.0024	0.0028	0.0028
Age spline (55–59)	−0.0063*	−0.0063*	−0.0064*	−0.0065*
Age spline (60–64)	−0.0037	−0.0038	−0.0041	−0.0039
Age spline (65–70)	−0.0146**	−0.0150**	−0.0149**	−0.0150**
Health limitation	−0.0337***	−0.0342***	−0.0351***	−0.0344***
Education = degree	0.0095	0.0091	0.0088	0.0093
Education = other HE	−0.0052	−0.0052	−0.0053	−0.0048
Education = A levels	0.0047	0.0042	0.0035	0.0044
Education = O levels	−0.0115	−0.0124	−0.0128	−0.0119
Education = NVQ1/CSE	−0.0034	−0.0051	−0.0070	−0.0056
Married	−0.0144	−0.0144	−0.0138	−0.0137
Outright owners	−0.0023	−0.0021	−0.0022	−0.0006
Owners with mg/loan	0.0277	0.0278	0.0272	0.0294
Occ = prof/man/tech	−0.0243*	−0.0234*	−0.0240*	−0.0239*
Occ = non-man skilled	−0.0029	−0.0011	−0.0015	−0.0017
Occ = manual skilled	−0.0014	−0.0004	−0.0002	−0.0006
Household size	0.0071	0.0069	0.0069	0.0069
D.(Date score)	0.0069			
D.(Immediate recall)	−0.0012	−0.0012		
D.(Verbal fluency)	−0.0009	−0.0008		
D.(Prospective memory)	−0.0004	−0.0002		
D.(Delayed recall)	−0.0026	−0.0027		
D.(CF index)			−0.0015	
D.(CF index w/o date)				−0.0028
Number of obs.	1,047	1,047	1,047	1,047
Log likelihood	−181.2473	−181.7797	−182.952	−182.2222
Observed P	0.0544	0.0544	0.0544	0.0544

Table 10: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the entry probit model for men.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0023	0.0023	0.0023	0.0023
$\sinh^{-1}$(Other wealth)	0.0001	0.0001	0.0001	0.0001
Age spline (50–54)	0.0037	0.0036	0.0036	0.0035
Age spline (55–59)	−0.0112***	−0.0110***	−0.0113***	−0.0112***
Age spline (60–64)	−0.0024	−0.0026	−0.0024	−0.0025
Age spline (65–70)	−0.0023	−0.0022	−0.0025	−0.0025
Health limitation	−0.0178**	−0.0177**	−0.0174**	−0.0173**
Education = degree	0.0153	0.0148	0.0153	0.0153
Education = other HE	0.0176	0.0178	0.0168	0.0167
Education = A levels	−0.0002	−0.0000	−0.0015	−0.0012
Education = O levels	0.0084	0.0086	0.0077	0.0079
Education = NVQ1/CSE	0.0061	0.0054	0.0063	0.0065
Education = other	0.0041	0.0044	0.0044	0.0046
Married	−0.0085	−0.0085	−0.0072	−0.0071
Outright owners	−0.0229	−0.0231	−0.0233	−0.0236
Owners with mg/loan	−0.0155	−0.0153	−0.0162	−0.0163
Occ = prof/man/tech	−0.0098	−0.0099	−0.0095	−0.0097
Occ = non-man skilled	0.0152	0.0150	0.0163	0.0162
Occ = manual skilled	0.0294	0.0293	0.0293	0.0294
Household size	0.0008	0.0006	0.0003	0.0002
D.(Date score)	−0.0062			
D.(Immediate recall)	0.0005	0.0004		
D.(Verbal fluency)	−0.0009	−0.0009		
D.(Prospective memory)	0.0020	0.0020		
D.(Delayed recall)	−0.0003	−0.0003		
D.(CF index)			−0.0005	
D.(CF index w/o date)				0.0000
Number of obs.	1,814	1,814	1,814	1,814
Log likelihood	−282.7835	−283.2108	−284.9902	−285.05
Observed P	0.0430	0.0430	0.0430	0.0430

Table 11: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the entry probit model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	−0.2034	−0.2040	−0.2005	−0.2014
$\sinh^{-1}$(Other wealth)	−0.1412***	−0.1411***	−0.1415***	−0.1413***
Age spline (50–54)	−0.4244	−0.4288	−0.4374	−0.4346
Age spline (55–59)	−0.3129	−0.3065	−0.3094	−0.3161
Age spline (60–64)	−0.2094	−0.2123	−0.2161	−0.2122
Age spline (65–70)	1.8188***	1.8116***	1.8326***	1.8285***
Health limitation	1.0698	1.0543	1.0153	1.0258
Education = degree	1.5908	1.5889	1.5441	1.5380
Education = other HE	1.2549	1.2541	1.2430	1.2355
Education = A levels	0.6789	0.6530	0.5486	0.5748
Education = O levels	0.9493	0.9268	0.8594	0.8800
Education = NVQ1/CSE	0.1881	0.1520	0.1241	0.1395
Education = other	0.5181	0.5187	0.4136	0.4302
Married	−1.3226	−1.3145	−1.3240	−1.3202
Outright owners	2.8369	2.8485	2.7878	2.8149
Owners with mg/loan	2.2884	2.2958	2.2472	2.2695
Occ = prof/man/tech	−1.4555	−1.4607	−1.4546	−1.4419
Occ = non-man skilled	−0.7356	−0.7329	−0.7209	−0.7153
Occ = manual skilled	−1.3062	−1.3031	−1.3092	−1.3057
Household size	0.1763	0.1744	0.1701	0.1693
D.(Date score)	0.2798			
D.(Immediate recall)	−0.1780	−0.1767		
D.(Verbal fluency)	−0.0818	−0.0804		
D.(Prospective memory)	0.0654	0.0693		
D.(Delayed recall)	0.0383	0.0413		
D.(CF index)			−0.0720	
D.(CF index w/o date)				−0.1229
Constant	20.6894	20.9249	21.4871	21.3321
Number of obs.	2,554	2,554	2,554	2,554
Adjusted R-squared	0.0141	0.0144	0.0142	0.0144

Table 12: OLS coefficients from the hours change model for men.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.2075**	0.2077**	0.2075**	0.2075**
$\sinh^{-1}$(Other wealth)	−0.0062	−0.0064	−0.0062	−0.0061
Age spline (50–54)	0.1125	0.1153	0.1125	0.1144
Age spline (55–59)	−1.0308***	−1.0338***	−1.0335***	−1.0356***
Age spline (60–64)	0.8872***	0.8916***	0.8943***	0.8947***
Age spline (65–70)	0.1776	0.1752	0.1719	0.1723
Health limitation	1.2069***	1.2057***	1.2205***	1.2159***
Education = degree	0.0944	0.1008	0.0965	0.0964
Education = other HE	−0.0673	−0.0754	−0.0852	−0.0820
Education = A levels	−1.3845*	−1.3806*	−1.3872*	−1.3839*
Education = O levels	−0.2014	−0.1937	−0.1983	−0.2012
Education = NVQ1/CSE	0.2396	0.2198	0.2283	0.2220
Education = other	0.8205	0.8174	0.8203	0.8205
Married	0.2752	0.2660	0.2738	0.2713
Outright owners	−3.2071***	−3.1997***	−3.1922***	−3.1947***
Owners with mg/loan	−4.4190***	−4.4128***	−4.4059***	−4.4127***
Occ = prof/man/tech	−1.0386*	−1.0420*	−1.0350*	−1.0367*
Occ = non-man skilled	−0.2861	−0.2861	−0.2822	−0.2816
Occ = manual skilled	−1.7984***	−1.7977***	−1.8001***	−1.7964***
Household size	0.3590	0.3615	0.3605	0.3619
D.(Date score)	0.2900			
D.(Immediate recall)	−0.0157	−0.0153		
D.(Verbal fluency)	−0.0104	−0.0095		
D.(Prospective memory)	0.0248	0.0238		
D.(Delayed recall)	−0.0158	−0.0160		
D.(CF index)			0.0074	
D.(CF index w/o date)				−0.0154
Constant	−6.5073	−6.6507	−6.5264	−6.6089
Number of obs.	3,030	3,030	3,030	3,030
Adjusted R-squared	0.0303	0.0304	0.0313	0.0313

Table 13: OLS coefficients from the hours change model for women.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

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Appendix A: The CF level and the probability to work

In Table 14, I report estimates from the 'levels equation' linking the level of CF to the probability to work. The CF coefficients are the same as those in the last column of Table 2 in the main body of the paper. For men, no CF coefficient is statistically significant. For women, I find statistically significant coefficients for the date score and for the prospective memory score.

Because of the likely endogeneity of the date score and because the prospective memory score is statistically significant only at the 10% level, one should not attach too much importance to these results. Note also that, even though there are two statistically significant coefficients in the regression for women, the effect size is quite small considering that the date score only ranges from 0 to 4 and the prospective memory score from 0 to 5. Compared to the effects of most of the control variables, the association of CF with the probability of working is small.

	(1)	(2)
$\sinh^{-1}$(Housing wealth)	0.0051	0.0040
$\sinh^{-1}$(Other wealth)	−0.0018	−0.0019
Age spline (50–54)	0.0411	0.0137
Age spline (55–59)	−0.0435***	−0.0467***
Age spline (60–64)	−0.0616***	−0.0641***
Age spline (65–70)	−0.0888***	−0.0271***
Health limitation	−0.3861***	−0.2030***
Education = degree	−0.0510	0.1076***
Education = other HE	−0.0427	0.0286
Education = A levels	0.0017	0.0489
Education = O levels	−0.0208	0.0241
Education = NVQ1/CSE	−0.0139	0.0284
Education = other	−0.0812	0.0974***
Married	0.0875***	−0.0756***
Outright owners	−0.0053	−0.0366
Owners with mg/loan	0.2086***	0.1019*
Occ = prof/man/tech	−0.0043	0.1318***
Occ = non-man skilled	−0.0324	0.1289***
Occ = manual skilled	0.0420	0.1027***
Household size	0.0144	−0.0020
L.(Date score)	0.0362	0.0421*
L.(Immediate recall)	0.0012	0.0091
L.(Verbal fluency)	0.0011	−0.0016
L.(Prospective memory)	0.0049	0.0127**
L.(Delayed recall)	−0.0021	−0.0054
Number of obs.	2,571	3,037
Log likelihood	−1159.354	−1345.517
Observed P	0.4831	0.3266

Table 14: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the levels probit model (dependent variable: whether individual works at least 16 hours or not).
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

Appendix B: Controlling for panel attrition

As mentioned in the main body of this paper, I found strong evidence for increased occurrence of panel attrition among those with low CF scores. If the process of attrition is linked to the process of the exit from work, the entry into work, or the process of changing working hours, this may bias my coefficient estimates. Therefore, I also carried out Heckman probit models for the exit from and the entry into work, and standard Heckman selection models for the change in working hours.

The selection equation is specified in a parsimonious way and includes only age, health, CF in wave 1, and the four additional dummy variables about (1) provision of a contact address, (2) agreement to record linkage, (3) document consultation, and (4) the interviewer's assessment of response reliability. These variables indicate how seriously the respondent took the survey, and therefore how likely it is that he or she will continue to participate in wave 2. I also argue that these variables are not directly linked to the labour market outcome under consideration.

Tables 15 and 16 report the results of the Heckman exit probit models for men and women. The top panel displays the exit equation, the bottom panel the selection equation ('1' if present in wave 2, '0' if not). First, note that ρ is never statistically significant, implying that the two equations are independent and that it is more efficient to estimate them separately. This is also shown by the likelihood-ratio test of independent equations which is usually not statistically significant.

Second, none of the CF variables is statistically significant in the exit equations, implying that the key result is the same as when not controlling for attrition. In other words, attrition is explained by the level of CF, but there are no effects of the change in CF on the probability to exit work, nor is there a link between attrition and exit.

Estimates of the Heckman entry probit models for men and women are reported in

Tables 17 and 18. The top panel displays the entry equation, the bottom panel the selection equation. As with the selection-corrected exit regressions, ρ is never statistically significant. There are no statistically significant effects of CF except for a negative effect of the change in verbal fluency on women's entry probability. However, the effect size is negligible. The Heckman entry probit models for women did not converge when using an index of CF rather than the individual CF variables. This is most likely due to the small number of entries observed among women.

The estimates of the Heckman selection model for the change in working hours for men and women are reported in Tables 19 and 20. Again, there is no statistically significant effect of CF on the change in working hours. However, ρ is statistically significant in regressions for women when using the individual CF variables. It has a negative value, implying that individuals with unobserved characteristics that make them more likely to increase their working hours are also individuals with unobserved characteristics that make them less likely to participate in the second wave (and vice versa). This is an interesting result in its own right but not crucial for my research in this study.

	(1)	(2)	(3)	(4)
Exit from work equation				
$\sinh^{-1}$(Housing wealth)	0.0124*	0.0129*	0.0135*	0.0139*
$\sinh^{-1}$(Other wealth)	0.0026**	0.0027**	0.0028**	0.0028**
Age spline (50–54)	0.0181**	0.0185**	0.0189**	0.0192**
Age spline (55–59)	0.0050	0.0053	0.0057	0.0057
Age spline (60–64)	0.0277***	0.0289***	0.0299***	0.0306***
Age spline (65–70)	−0.0652***	−0.0655***	−0.0659***	−0.0661***
Health limitation	0.0270	0.0294	0.0321	0.0336
Education = degree	0.0146	0.0148	0.0132	0.0133
Education = other HE	0.0000	−0.0006	−0.0002	−0.0008
Education = A levels	−0.0164	−0.0173	−0.0176	−0.0179
Education = O levels	−0.0030	−0.0035	−0.0026	−0.0029
Education = NVQ1/CSE	−0.0127	−0.0136	−0.0100	−0.0104
Education = other	0.0086	0.0091	0.0103	0.0103
Married	−0.0075	−0.0079	−0.0096	−0.0096
Outright owners	−0.1458*	−0.1507*	−0.1559*	−0.1598*
Owners with mg/loan	−0.1750**	−0.1807**	−0.1864**	−0.1909**
Occ = prof/man/tech	0.0015	0.0013	0.0015	0.0016
Occ = non-man skilled	0.0159	0.0158	0.0172	0.0176
Occ = manual skilled	−0.0039	−0.0043	−0.0053	−0.0050
Household size	−0.0097	−0.0097	−0.0096	−0.0098
D.(Date score)	0.0041			
D.(Immediate recall)	0.0015	0.0016		
D.(Verbal fluency)	−0.0010	−0.0010		
D.(Prospective memory)	−0.0008	−0.0008		
D.(Delayed recall)	−0.0016	−0.0015		
D.(CF index)			−0.0010	
D.(CF index w/o date)				−0.0015
Sample retention equation				
Age spline (50–54)	−0.0141	−0.0140	−0.0153	−0.0149
Age spline (55–59)	−0.0128	−0.0131	−0.0123	−0.0127
Age spline (60–64)	−0.0174	−0.0173	−0.0190*	−0.0187*
Age spline (65–70)	−0.1776***	−0.1777***	−0.1749***	−0.1751***
Health limitation	−0.1867***	−0.1869***	−0.1861***	−0.1850***
R consulted docs	0.0451**	0.0455**	0.0471**	0.0471**
Response reliability	−0.0376*	−0.0372*	−0.0368*	−0.0368*
R gave contact address	0.0633***	0.0634***	0.0635***	0.0634***
R agreed to record linkage	0.0751**	0.0761**	0.0720**	0.0728**
Date score	0.0149			
Immediate recall	0.0231**	0.0232**		
Verbal fluency	0.0093***	0.0093***		
Prospective memory	0.0071	0.0072		
Delayed recall	−0.0057	−0.0052		
CF index			0.0211***	
CF index w/o date				0.0235***
Number of obs.	2,336	2,336	2,336	2,336
Log likelihood	−1667.584	−1667.9	−1674.153	−1673.766
ρ	0.7449*	0.7030*	0.6608	0.6370

Table 15: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the Heckman exit probit model for men. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
Exit from work equation				
$\sinh^{-1}$(Housing wealth)	−0.0053	−0.0053	−0.0055	−0.0053
$\sinh^{-1}$(Other wealth)	0.0030	0.0029	0.0031	0.0030
Age spline (50–54)	0.0025	0.0024	0.0024	0.0023
Age spline (55–59)	0.0540***	0.0524***	0.0563***	0.0530***
Age spline (60–64)	0.0055	0.0047	0.0059	0.0049
Age spline (65–70)	−0.0584**	−0.0585**	−0.0560**	−0.0580**
Health limitation	0.0437	0.0401	0.0478	0.0417
Education = degree	−0.0728*	−0.0693*	−0.0741*	−0.0690*
Education = other HE	0.0163	0.0190	0.0204	0.0205
Education = A levels	0.0140	0.0147	0.0162	0.0158
Education = O levels	−0.0013	−0.0005	−0.0008	0.0005
Education = NVQ1/CSE	0.0186	0.0237	0.0240	0.0251
Education = other	−0.0734**	−0.0702**	−0.0730**	−0.0692**
Married	0.0342	0.0343	0.0365	0.0349
Outright owners	0.1112*	0.1107*	0.1166*	0.1110*
Owners with mg/loan	0.0658	0.0659	0.0682	0.0653
Occ = prof/man/tech	−0.0341	−0.0333	−0.0366	−0.0335
Occ = non-man skilled	−0.0434	−0.0422	−0.0458	−0.0427
Occ = manual skilled	0.0159	0.0152	0.0181	0.0162
Household size	−0.0165	−0.0167	−0.0172	−0.0165
D.(Date score)	−0.0277			
D.(Immediate recall)	−0.0035	−0.0037		
D.(Verbal fluency)	−0.0009	−0.0010		
D.(Prospective memory)	−0.0009	−0.0009		
D.(Delayed recall)	0.0014	0.0014		
D.(CF index)			−0.0040	
D.(CF index w/o date)				−0.0025
Sample retention equation				
Age spline (50–54)	0.0077	0.0073	0.0076	0.0070
Age spline (55–59)	−0.0214**	−0.0218**	−0.0211**	−0.0215**
Age spline (60–64)	−0.0314**	−0.0316**	−0.0312**	−0.0315**
Age spline (65–70)	−0.1603***	−0.1602***	−0.1608***	−0.1606***
Health limitation	−0.1587***	−0.1598***	−0.1579***	−0.1591***
R consulted docs	0.0462**	0.0470**	0.0463**	0.0474**
Response reliability	−0.0139	−0.0137	−0.0144	−0.0141
R gave contact address	0.0509**	0.0502*	0.0518**	0.0505**
R agreed to record linkage	0.1380***	0.1375***	0.1377***	0.1375***
Date score	0.0444			
Immediate recall	0.0277***	0.0279***		
Verbal fluency	0.0048**	0.0049**		
Prospective memory	0.0215***	0.0225***		
Delayed recall	0.0140	0.0146*		
CF index			0.0340***	
CF index w/o date				0.0360***
Number of obs.	2,158	2,158	2,158	2,158
Log likelihood	−1587.646	−1589.132	−1588.678	−1589.507
ρ	0.4179	0.4424	0.3710	0.4307

Table 16: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the Heckman exit probit model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
Entry to work equation				
$\sinh^{-1}$(Housing wealth)	0.0012	0.0012	0.0005	0.0010
$\sinh^{-1}$(Other wealth)	0.0002	0.0002	0.0001	0.0002
Age spline (50–54)	−0.0002	−0.0001	−0.0000	−0.0000
Age spline (55–59)	−0.0027	−0.0026	−0.0010	−0.0023
Age spline (60–64)	−0.0020	−0.0020	−0.0007	−0.0017
Age spline (65–70)	−0.0063	−0.0063	−0.0032	−0.0063
Health limitation	−0.0138	−0.0136	−0.0060	−0.0125
Education = degree	0.0043	0.0040	0.0020	0.0041
Education = other HE	−0.0017	−0.0017	−0.0007	−0.0013
Education = A levels	0.0030	0.0028	0.0013	0.0030
Education = O levels	−0.0056	−0.0061	−0.0025	−0.0050
Education = NVQ1/CSE	−0.0009	−0.0019	−0.0012	−0.0021
Education = other	−0.1984	−0.1993	−0.1459	−0.1774
Married	−0.0066	−0.0064	−0.0026	−0.0055
Outright owners	−0.0004	−0.0003	0.0000	0.0009
Owners with mg/loan	0.0159	0.0153	0.0072	0.0158
Occ = prof/man/tech	−0.0099	−0.0092	−0.0042	−0.0087
Occ = non-man skilled	−0.0001	0.0010	0.0003	0.0005
Occ = manual skilled	0.0011	0.0016	0.0007	0.0014
Household size	0.0035	0.0033	0.0014	0.0031
D.(Date score)	0.0037			
D.(Immediate recall)	−0.0002	−0.0002		
D.(Verbal fluency)	−0.0003	−0.0002		
D.(Prospective memory)	−0.0002	−0.0000		
D.(Delayed recall)	−0.0015	−0.0015		
D.(CF index)			−0.0002	
D.(CF index w/o date)				−0.0010
Sample retention equation				
Age spline (50–54)	0.0097	0.0103	0.0101	0.0101
Age spline (55–59)	0.0254**	0.0259**	0.0259**	0.0253**
Age spline (60–64)	0.0838***	0.0834***	0.0805***	0.0820***
Age spline (65–70)	−0.1615***	−0.1613***	−0.1600***	−0.1603***
Health limitation	0.0619**	0.0630**	0.0601**	0.0628**
R consulted docs	0.0634***	0.0638***	0.0652***	0.0640***
Response reliability	0.0397*	0.0389*	0.0367*	0.0366*
R gave contact address	0.0629**	0.0642**	0.0708***	0.0674***
R agreed to record linkage	0.0932***	0.0932***	0.0893**	0.0895**
Date score	−0.0242			
Immediate recall	0.0294***	0.0289***		
Verbal fluency	0.0066***	0.0065***		
Prospective memory	0.0002	0.0000		
Delayed recall	0.0080	0.0075		
CF index			0.0207***	
CF index w/o date				0.0258***
Number of obs.	1,955	1,955	1,955	1,955
Log likelihood	−1277.621	−1278.802	−1286.525	−1282.734
ρ	−0.0767	−0.0706	0.0779	−0.0090

Table 17: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the Heckman entry probit model for men. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)
Entry to work equation		
$\sinh^{-1}$(Housing wealth)	0.0015	0.0015
$\sinh^{-1}$(Other wealth)	−0.0002	−0.0002
Age spline (50–54)	0.0027	0.0027
Age spline (55–59)	−0.0057***	−0.0057***
Age spline (60–64)	−0.0007	−0.0008
Age spline (65–70)	−0.0049	−0.0049
Health limitation	−0.0089*	−0.0088*
Education = degree	0.0125	0.0121
Education = other HE	0.0129	0.0130
Education = A levels	0.0016	0.0018
Education = O levels	0.0060	0.0061
Education = NVQ1/CSE	0.0114	0.0118
Education = other	−0.0016	−0.0015
Married	−0.0060	−0.0058
Outright owners	−0.0160	−0.0161
Owners with mg/loan	−0.0154	−0.0153
Occ = prof/man/tech	−0.0046	−0.0044
Occ = non-man skilled	0.0117	0.0116
Occ = manual skilled	0.0228*	0.0231*
Household size	−0.0001	−0.0002
D.(Date score)	−0.0021	
D.(Immediate recall)	0.0001	0.0000
D.(Verbal fluency)	−0.0008**	−0.0008**
D.(Prospective memory)	0.0009	0.0009
D.(Delayed recall)	−0.0009	−0.0009
Sample retention equation		
Age spline (50–54)	0.0314**	0.0311**
Age spline (55–59)	0.0228**	0.0228**
Age spline (60–64)	0.0689***	0.0690***
Age spline (65–70)	−0.1709***	−0.1709***
Health limitation	0.0583***	0.0588***
R consulted docs	0.0547***	0.0541***
Response reliability	0.0069	0.0075
R gave contact address	0.0566***	0.0568***
R agreed to record linkage	0.0688**	0.0696***
Date score	−0.0285	
Immediate recall	0.0102	0.0099
Verbal fluency	0.0067***	0.0066***
Prospective memory	0.0076	0.0069
Delayed recall	0.0111	0.0106
Number of obs.	2,647	2,647
Log likelihood	−1673.059	−1674.073
ρ	0.9551	0.9720

Table 18: Marginal effects (evaluated at $\bar{\mathbf{x}}$) from the Heckman entry probit model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
Hours change equation				
$\sinh^{-1}$(Housing wealth)	−0.1618	−0.1640	−0.1626	−0.1651
$\sinh^{-1}$(Other wealth)	−0.0915*	−0.0902*	−0.0876*	−0.0893*
Age spline (50–54)	−0.4592	−0.4643	−0.4589	−0.4642
Age spline (55–59)	0.0190	0.0232	0.0155	0.0182
Age spline (60–64)	−0.8851***	−0.8920***	−0.8924***	−0.8874***
Age spline (65–70)	4.6504***	4.6499***	4.6728***	4.6567***
Health limitation	2.4056***	2.3826***	2.3816***	2.3682***
Education = degree	1.0576	1.0213	1.0353	1.0035
Education = other HE	0.9220	0.8969	0.9352	0.9070
Education = A levels	0.0402	−0.0185	−0.0518	−0.0546
Education = O levels	0.0437	−0.0127	−0.0236	−0.0122
Education = NVQ1/CSE	0.7614	0.7174	0.7783	0.7636
Education = other	−0.3252	−0.3502	−0.4817	−0.4910
Married	−1.7281**	−1.7000**	−1.6404**	−1.6695**
Outright owners	2.7414	2.7548	2.7249	2.7827
Owners with mg/loan	2.7698	2.7596	2.7148	2.7976
Occ = prof/man/tech	−1.6672*	−1.6597*	−1.6022*	−1.6715*
Occ = non-man skilled	−0.5280	−0.4911	−0.4209	−0.5098
Occ = manual skilled	−0.9732	−0.9574	−0.9269	−0.9835
Household size	0.4083	0.4061	0.4202	0.4232
D.(Date score)	0.2591			
D.(Immediate recall)	0.0602	0.0551		
D.(Verbal fluency)	−0.0307	−0.0292		
D.(Prospective memory)	0.0767	0.0818		
D.(Delayed recall)	−0.0698	−0.0635		
D.(CF index)			0.0583	
D.(CF index w/o date)				0.0200
Constant	25.3604	25.6445	25.2371	25.5909
Sample retention equation				
Age spline (50–54)	0.0003	0.0004	−0.0025	−0.0022
Age spline (55–59)	−0.0087	−0.0080	−0.0067	−0.0073
Age spline (60–64)	0.0867***	0.0863***	0.0818***	0.0838***
Age spline (65–70)	−0.4071***	−0.4064***	−0.4032***	−0.4041***
Health limitation	−0.1807***	−0.1790***	−0.1810***	−0.1777***
R consulted docs	0.0782**	0.0783**	0.0807***	0.0789***
Response reliability	−0.0033	−0.0051	−0.0117	−0.0100
R gave contact address	0.0638	0.0651	0.0692*	0.0670
R agreed to record linkage	0.1712***	0.1724***	0.1724***	0.1688***
Date score	−0.0405			
Immediate recall	0.0426**	0.0418**		
Verbal fluency	0.0145***	0.0143***		
Prospective memory	0.0061	0.0058		
Delayed recall	0.0089	0.0082		
CF index			0.0371***	
CF index w/o date				0.0452***
Constant	0.1678	0.0263	0.7989	0.7807
Number of obs.	3,366	3,366	3,366	3,366
Log likelihood	−11512.61	−11513.48	−11521.57	−11518.21
ρ	−0.8566***	−0.8557***	−0.8535***	−0.8545***

Table 19: Heckman selection model coefficients from the hours change model for men. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
Hours change equation				
$\sinh^{-1}$(Housing wealth)	0.2328***	0.2340***	0.2289***	0.2310***
$\sinh^{-1}$(Other wealth)	0.0061	0.0060	0.0068	0.0071
Age spline (50–54)	0.0934	0.0950	0.0941	0.0949
Age spline (55–59)	−1.0105***	−1.0123***	−1.0131***	−1.0153***
Age spline (60–64)	0.3754**	0.3790**	0.3831**	0.3843**
Age spline (65–70)	2.2207***	2.2199***	2.2150***	2.2121***
Health limitation	1.4468***	1.4416***	1.4727***	1.4664***
Education = degree	−0.5675	−0.5554	−0.5043	−0.5134
Education = other HE	−0.2789	−0.2855	−0.2503	−0.2619
Education = A levels	−1.6055*	−1.5971*	−1.5682*	−1.5781*
Education = O levels	−0.6087	−0.5995	−0.5944	−0.6104
Education = NVQ1/CSE	0.2438	0.2172	0.2321	0.2112
Education = other	0.6902	0.6861	0.6957	0.6876
Married	0.0716	0.0588	0.0736	0.0620
Outright owners	−3.6638***	−3.6725***	−3.5888***	−3.6192***
Owners with mg/loan	−4.4886***	−4.4958***	−4.4407***	−4.4729***
Occ = prof/man/tech	−0.9952	−1.0014	−0.9731	−0.9829
Occ = non-man skilled	−0.5205	−0.5141	−0.5173	−0.5031
Occ = manual skilled	−1.2929*	−1.2969*	−1.2754*	−1.2811*
Household size	0.2668	0.2675	0.2860	0.2823
D.(Date score)	0.3402			
D.(Immediate recall)	0.0784	0.0796		
D.(Verbal fluency)	0.0085	0.0099		
D.(Prospective memory)	0.0943	0.0952		
D.(Delayed recall)	−0.0068	−0.0052		
D.(CF index)			0.1143	
D.(CF index w/o date)				0.1019
Constant	−2.0468	−2.1202	−2.1871	−2.1930
Sample retention equation				
Age spline (50–54)	0.0573**	0.0571**	0.0571**	0.0564**
Age spline (55–59)	−0.0159	−0.0162	−0.0165	−0.0166
Age spline (60–64)	0.0967***	0.0965***	0.0965***	0.0963***
Age spline (65–70)	−0.4117***	−0.4116***	−0.4117***	−0.4111***
Health limitation	−0.1051**	−0.1063**	−0.1049**	−0.1062**
R consulted docs	0.0554*	0.0560*	0.0556*	0.0571*
Response reliability	0.0506	0.0501	0.0526	0.0511
R gave contact address	0.1254***	0.1250***	0.1241***	0.1231***
R agreed to record linkage	0.1008*	0.0996*	0.1020*	0.0996*
Date score	0.0378			
Immediate recall	0.0264	0.0268		
Verbal fluency	0.0154***	0.0155***		
Prospective memory	0.0189	0.0196		
Delayed recall	0.0170	0.0177		
CF index			0.0470***	
CF index w/o date				0.0516***
Constant	−3.2233**	−3.0772**	−2.4553*	−2.4059*
Number of obs.	3,824	3,824	3,824	3,824
Log likelihood	−12463.73	−12464.25	−12467.06	−12466.77
ρ	−0.7900***	−0.7898***	−0.7901***	−0.7889***

Table 20: Heckman selection model coefficients from the hours change model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

Appendix C: Wage and earnings regressions

In line with Anger and Heineck (2006), Cawley, Heckman, and Vytlacil (2001), Heckman and Vytlacil (2001), and Pryor and Schaffer (2000), I also used (log) wages and (log) earnings as dependent variables. I used monthly RPI data from National Statistics to convert all monetary amounts to January 2005 pounds.[16]

As mentioned in the main body of this paper, I excluded the self-employed from my wage and earnings regressions since the unexplained variation in self-employment income is much larger than that in employment income and since there is the problem of negative self-employment income. However, the key results, in particular those for the effects of CF, are similar even when including the self-employed.

The data on wages and earnings come from the derived financial variable files of ELSA and contain imputed data. In other words, item non-response has already been addressed by the data depositors. However, there is of course the usual problem of selection into work which is why it may be useful to estimate Heckman selection models rather than standard OLS regressions.

As expected for reasons discussed in the introduction to the paper, the explanatory power of these models is much lower than that of the participation models, and lower than that of income regressions for the general working-age population.

The estimates of OLS regressions explaining the change in the wage rate for men and women are reported in Tables 21 and 22. Again, I do not find any statistically significant effects of CF. The wage change for this age group seems to be driven just by education.

For the wage models it may be important to control for attrition. Tables 27 and 28 show the estimates of Heckman selection models explaining the wage change. I find that for men, the difference in delayed recall has an impact on the wage change. In other words, every

[16]The time series used is called CHAW. This is the full RPI including all components such as housing and mortgage repayments.

decline in the delayed recall of the word list by one word is associated with a fall of the hourly wage rate by 50 pence. Consider two otherwise identical men, both of whom scored 4 out of 4 on the delayed recall in wave 1. In wave 2, person A is again able to remember all four words whereas person B only remembers two words. Therefore, person B is predicted to experience a wage change that is one pound lower than that of person A.

For women, I do not find such an effect. Moreover, for both sexes, ρ is not statistically significant, implying that the wage change model should be estimated separately from the attrition model as doing so is more efficient.

When including numeracy and/or literacy in these wage and earnings models, I do find statistically significant effects, except for the effect of the contemporaneous literacy score on earnings. A man's wage rate is predicted to be 7% higher for a one-point increase in the literacy score (which ranges from 0 to 3) and 4% higher for a one-point increase in the first-wave numeracy score (which ranges from 0 to 6). Women's earnings are predicted to be 5% higher for a one-point increase in the first-wave numeracy score and a woman's wage rate is predicted to be 7% higher for a one-point increase in that variable.[17]

[17] Since ρ is statistically significant in men's but not in women's regressions, these results refer to the Heckman selection model for men and to the OLS model for women.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	−0.1121	−0.1137	−0.1172	−0.1186
$\sinh^{-1}$(Other wealth)	0.0785	0.0825	0.0848	0.0847
Age spline (50–54)	0.7655	0.7528	0.7441	0.7435
Age spline (55–59)	0.0383	0.0491	−0.0217	−0.0244
Age spline (60–64)	−1.2231	−1.2133	−1.1381	−1.1371
Age spline (65–70)	1.6305	1.5494	1.5789	1.5556
Health limitation	−1.2512	−1.3009	−1.4134	−1.4104
Education = degree	−0.4912	−0.4320	−0.7266	−0.7413
Education = other HE	6.0584*	6.1444*	6.0525*	6.0275*
Education = A levels	−1.7841	−1.7943	−2.0285	−2.0416
Education = O levels	0.9875	1.0039	0.6458	0.6441
Education = NVQ1/CSE	−1.3394	−1.3328	−1.3300	−1.3685
Education = other	−1.4363	−1.3159	−1.2244	−1.1789
Married	1.7367	1.8531	1.7710	1.7955
Outright owners	2.2074	2.2605	2.2023	2.2535
Owners with mg/loan	0.1468	0.1958	0.3224	0.3674
Occ = prof/man/tech	4.3806	4.2611	4.4047	4.3875
Occ = non-man skilled	0.1429	0.0124	0.2729	0.2344
Occ = manual skilled	0.2258	0.1578	0.3248	0.3051
Household size	−0.7087	−0.7184	−0.5983	−0.6015
D.(Date score)	0.8371			
D.(Immediate recall)	−0.0095	−0.0110		
D.(Verbal fluency)	−0.2617*	−0.2590*		
D.(Prospective memory)	0.2758	0.2897		
D.(Delayed recall)	0.4004	0.4161		
D.(CF index)			0.0591	
D.(CF index w/o date)				−0.0112
Constant	−40.5190	−39.9524	−39.5668	−39.5320
Number of obs.	970	970	970	970
Adjusted R-squared	−0.0030	−0.0022	−0.0028	−0.0028

Table 21: OLS coefficients from the wage change model for men.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.1017	0.1246	0.1178	0.1237
$\sinh^{-1}$(Other wealth)	0.0028	0.0081	0.0057	0.0084
Age spline (50–54)	0.1634	0.1838	0.1739	0.1961
Age spline (55–59)	0.2194	0.2352	0.2353	0.2241
Age spline (60–64)	−0.9848*	−1.0071*	−1.0040*	−1.0034*
Age spline (65–70)	1.3525	1.3919	1.4090	1.4146
Health limitation	−0.2496	−0.1820	−0.1983	−0.2058
Education = degree	0.6475	0.6290	0.5471	0.5794
Education = other HE	2.6099	2.5405	2.5030	2.4904
Education = A levels	0.5726	0.6031	0.5431	0.5819
Education = O levels	0.7680	0.8068	0.7812	0.7740
Education = NVQ1/CSE	2.3468	2.1893	2.1258	2.1057
Education = other	2.6770*	2.6716*	2.6147	2.6113
Married	−0.6263	−0.7214	−0.7214	−0.7490
Outright owners	−0.9226	−1.2091	−1.1526	−1.2332
Owners with mg/loan	0.6997	0.4188	0.4792	0.3936
Occ = prof/man/tech	−0.2564	−0.2836	−0.2518	−0.2871
Occ = non-man skilled	−0.6818	−0.7640	−0.7258	−0.7571
Occ = manual skilled	−1.0388	−1.0650	−1.0483	−1.0391
Household size	0.1378	0.1505	0.1306	0.1335
D.(Date score)	1.7859*			
D.(Immediate recall)	0.2076	0.2144		
D.(Verbal fluency)	0.0111	0.0194		
D.(Prospective memory)	−0.0322	−0.0370		
D.(Delayed recall)	−0.0238	−0.0460		
D.(CF index)			0.1861	
D.(CF index w/o date)				0.0899
Constant	−9.9626	−10.9811	−10.4229	−11.5169
Number of obs.	1,065	1,065	1,065	1,065
Adjusted R-squared	−0.0076	−0.0096	−0.0064	−0.0072

Table 22: OLS coefficients from the wage change model for women.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0128	0.0128	0.0124	0.0123
$\sinh^{-1}$(Other wealth)	0.0071**	0.0072**	0.0072**	0.0070**
Age spline (50–54)	−0.0043	−0.0042	−0.0010	−0.0021
Age spline (55–59)	0.0012	0.0012	0.0003	0.0005
Age spline (60–64)	−0.0361*	−0.0360*	−0.0362*	−0.0361*
Age spline (65–70)	−0.0169	−0.0170	−0.0172	−0.0166
Health limitation	−0.0119	−0.0117	−0.0140	−0.0144
Education = degree	0.3141***	0.3134***	0.3191***	0.3176***
Education = other HE	0.2006**	0.2003**	0.1994**	0.1977**
Education = A levels	0.1144	0.1134	0.1119	0.1116
Education = O levels	0.1280*	0.1270*	0.1254*	0.1259*
Education = NVQ1/CSE	−0.0233	−0.0230	−0.0179	−0.0192
Education = other	−0.1215	−0.1215	−0.1249	−0.1249
Married	−0.0743	−0.0736	−0.0718	−0.0738
Outright owners	−0.1554	−0.1552	−0.1494	−0.1482
Owners with mg/loan	−0.0817	−0.0819	−0.0751	−0.0732
Occ = prof/man/tech	0.3734***	0.3723***	0.3712***	0.3718***
Occ = non-man skilled	0.0502	0.0490	0.0440	0.0452
Occ = manual skilled	0.0675	0.0670	0.0643	0.0647
Household size	0.0223	0.0224	0.0238	0.0236
L.(Date score)	−0.0112			
L.(Immediate recall)	0.0148	0.0149		
L.(Verbal fluency)	0.0030	0.0030		
L.(Prospective memory)	−0.0039	−0.0039		
L.(Delayed recall)	0.0185	0.0183		
L.(CF index)			0.0168*	
L.(CF index w/o date)				0.0193**
Constant	1.6437	1.5956	1.6419	1.7082
Number of obs.	1,018	1,018	1,018	1,018
Adjusted R-squared	0.1467	0.1475	0.1482	0.1487

Table 23: OLS coefficients from the ln(wage) model for men.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0138	0.0138	0.0141	0.0141
$\sinh^{-1}$(Other wealth)	0.0052	0.0052	0.0053	0.0052
Age spline (50–54)	0.0254	0.0254	0.0240	0.0241
Age spline (55–59)	0.0119	0.0119	0.0120	0.0120
Age spline (60–64)	−0.0167	−0.0167	−0.0179	−0.0179
Age spline (65–70)	−0.0289	−0.0289	−0.0272	−0.0271
Health limitation	0.0544	0.0545	0.0564	0.0563
Education = degree	0.4945***	0.4942***	0.4989***	0.4985***
Education = other HE	0.3672***	0.3670***	0.3735***	0.3732***
Education = A levels	0.0765	0.0764	0.0790	0.0786
Education = O levels	0.0745	0.0745	0.0753	0.0750
Education = NVQ1/CSE	0.1307	0.1305	0.1316	0.1315
Education = other	0.1090	0.1089	0.1109	0.1108
Married	0.0189	0.0188	0.0196	0.0197
Outright owners	−0.2196	−0.2195	−0.2191	−0.2190
Owners with mg/loan	−0.2113	−0.2114	−0.2105	−0.2103
Occ = prof/man/tech	0.1787**	0.1786**	0.1777**	0.1775**
Occ = non-man skilled	0.1223**	0.1220**	0.1231**	0.1230**
Occ = manual skilled	0.0436	0.0435	0.0431	0.0430
Household size	0.0243	0.0243	0.0237	0.0237
L.(Date score)	−0.0040			
L.(Immediate recall)	0.0060	0.0060		
L.(Verbal fluency)	−0.0003	−0.0003		
L.(Prospective memory)	−0.0083	−0.0083		
L.(Delayed recall)	0.0029	0.0028		
L.(CF index)			0.0009	
L.(CF index w/o date)				0.0012
Constant	0.0557	0.0429	0.1223	0.1185
Number of obs.	1,118	1,118	1,118	1,118
Adjusted R-squared	0.0841	0.0849	0.0868	0.0869

Table 24: OLS coefficients from the ln(wage) model for women.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0129	0.0129	0.0127	0.0125
$\sinh^{-1}$(Other wealth)	0.0068*	0.0068*	0.0069*	0.0068*
Age spline (50–54)	−0.0030	−0.0031	−0.0002	−0.0010
Age spline (55–59)	−0.0079	−0.0079	−0.0084	−0.0082
Age spline (60–64)	−0.0395**	−0.0395**	−0.0394**	−0.0394**
Age spline (65–70)	−0.0730**	−0.0730**	−0.0752**	−0.0747**
Health limitation	−0.0363	−0.0364	−0.0387	−0.0390
Education = degree	0.2788***	0.2789***	0.2820***	0.2817***
Education = other HE	0.1959**	0.1959**	0.1931**	0.1924**
Education = A levels	0.1405	0.1406	0.1410	0.1416
Education = O levels	0.1208	0.1210	0.1212	0.1226
Education = NVQ1/CSE	−0.0152	−0.0152	−0.0078	−0.0089
Education = other	−0.1322	−0.1321	−0.1327	−0.1326
Married	−0.0713	−0.0714	−0.0695	−0.0714
Outright owners	−0.1546	−0.1546	−0.1474	−0.1465
Owners with mg/loan	−0.0734	−0.0734	−0.0657	−0.0641
Occ = prof/man/tech	0.3755***	0.3757***	0.3724***	0.3737***
Occ = non-man skilled	0.0642	0.0644	0.0587	0.0606
Occ = manual skilled	0.1007	0.1007	0.0966	0.0970
Household size	0.0244	0.0243	0.0251	0.0248
Weekly working hours	0.0290***	0.0290***	0.0289***	0.0289***
L.(Date score)	0.0015			
L.(Immediate recall)	0.0035	0.0035		
L.(Verbal fluency)	0.0019	0.0019		
L.(Prospective memory)	0.0018	0.0018		
L.(Delayed recall)	0.0243	0.0243		
L.(CF index)			0.0165*	
L.(CF index w/o date)				0.0181*
Constant	4.0586	4.0651	4.0896	4.1350
Number of obs.	1,018	1,018	1,018	1,018
Adjusted R-squared	0.3160	0.3167	0.3178	0.3180

Table 25: OLS coefficients from the ln(earnings) model for men.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
$\sinh^{-1}$(Housing wealth)	0.0089	0.0089	0.0089	0.0089
$\sinh^{-1}$(Other wealth)	0.0027	0.0027	0.0028	0.0028
Age spline (50–54)	0.0238	0.0238	0.0237	0.0238
Age spline (55–59)	−0.0067	−0.0067	−0.0065	−0.0066
Age spline (60–64)	−0.0517**	−0.0517**	−0.0514**	−0.0514**
Age spline (65–70)	−0.0173	−0.0173	−0.0172	−0.0172
Health limitation	0.0063	0.0062	0.0067	0.0065
Education = degree	0.4402***	0.4404***	0.4367***	0.4369***
Education = other HE	0.2573***	0.2575***	0.2544***	0.2546***
Education = A levels	0.0699	0.0700	0.0687	0.0687
Education = O levels	0.0566	0.0566	0.0565	0.0563
Education = NVQ1/CSE	0.0939	0.0941	0.0921	0.0924
Education = other	0.1213	0.1213	0.1202	0.1202
Married	−0.0409	−0.0409	−0.0407	−0.0406
Outright owners	−0.2021	−0.2021	−0.2002	−0.2002
Owners with mg/loan	−0.1447	−0.1446	−0.1423	−0.1420
Occ = prof/man/tech	0.3250***	0.3250***	0.3243***	0.3243***
Occ = non-man skilled	0.2498***	0.2500***	0.2494***	0.2497***
Occ = manual skilled	0.1273	0.1273	0.1269	0.1270
Household size	0.0307	0.0307	0.0302	0.0301
Weekly working hours	0.0331***	0.0331***	0.0331***	0.0331***
L.(Date score)	0.0032			
L.(Immediate recall)	0.0055	0.0055		
L.(Verbal fluency)	−0.0007	−0.0007		
L.(Prospective memory)	0.0033	0.0033		
L.(Delayed recall)	0.0013	0.0014		
L.(CF index)			0.0033	
L.(CF index w/o date)				0.0035
Constant	2.4078	2.4182	2.4610	2.4573
Number of obs.	1,118	1,118	1,118	1,118
Adjusted R-squared	0.4213	0.4218	0.4233	0.4233

Table 26: OLS coefficients from the ln(earnings) model for women.
***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
Wage change equation				
$\sinh^{-1}$(Housing wealth)	−0.0979	−0.1051	−0.0906	−0.1002
$\sinh^{-1}$(Other wealth)	−0.0234	−0.0137	−0.0273	−0.0213
Age spline (50–54)	0.2369	0.2299	0.2086	0.2195
Age spline (55–59)	−0.8736	−0.8724	−0.8709	−0.8919
Age spline (60–64)	−3.1383***	−3.0898***	−3.1776***	−3.1590***
Age spline (65–70)	−9.5271***	−9.7302***	−9.5893***	−9.6971***
Health limitation	−11.7550***	−11.8197***	−11.8815***	−11.8613***
Education = degree	−2.0582	−2.0041	−2.3714	−2.3991
Education = other HE	3.5257*	3.7138*	3.6091*	3.5739*
Education = A levels	2.1083	1.9115	1.7341	1.6599
Education = O levels	1.9568	1.9721	1.3934	1.3968
Education = NVQ1/CSE	−0.7759	−0.7787	−0.5529	−0.5877
Education = other	−1.4403	−1.3229	−1.7320	−1.8387
Married	4.7237**	4.9541***	4.7473**	4.8905***
Outright owners	−1.2461	−1.3422	−1.0089	−0.8515
Owners with mg/loan	−0.5699	−0.5471	−0.0463	0.1723
Occ = prof/man/tech	2.3929	2.1616	2.6459	2.5351
Occ = non-man skilled	0.8674	0.4846	0.9836	0.7682
Occ = manual skilled	1.0648	0.9090	0.9929	0.9467
Household size	−2.4652***	−2.5025***	−2.3698***	−2.4029***
D.(Date score)	1.0590			
D.(Immediate recall)	0.0024	0.0060		
D.(Verbal fluency)	−0.2878***	−0.2785***		
D.(Prospective memory)	−0.1073	−0.0654		
D.(Delayed recall)	0.0013	0.0185		
D.(CF index)			−0.2745	
D.(CF index w/o date)				−0.3962
Constant	−14.6708	−14.2616	−13.7775	−14.3401
Sample retention equation				
Age spline (50–54)	−0.0211	−0.0228	−0.0187	−0.0175
Age spline (55–59)	−0.0264	−0.0260	−0.0259	−0.0268
Age spline (60–64)	−0.0990***	−0.1002***	−0.1000***	−0.0999***
Age spline (65–70)	−0.3691***	−0.3677***	−0.3642***	−0.3644***
Health limitation	−0.5054***	−0.5056***	−0.4934***	−0.4921***
R consulted docs	0.0823**	0.0839**	0.0759**	0.0807**
Response reliability	−0.0371	−0.0372	−0.0313	−0.0338
R gave contact address	0.0675	0.0705	0.0660	0.0651
R agreed to record linkage	0.0938*	0.0933*	0.0823	0.0787
Date score	0.0076			
Immediate recall	0.0580***	0.0587***		
Verbal fluency	0.0136***	0.0135***		
Prospective memory	0.0251*	0.0256*		
Delayed recall	−0.0189	−0.0188		
CF index			0.0386***	
CF index w/o date				0.0436***
Constant	0.7994	0.9103	1.3300	1.2788
Number of obs.	1,781	1,781	1,781	1,781
Log likelihood	−5097.182	−5097.853	−5105.153	−5104.226
ρ	0.9816***	0.9815***	0.9794***	0.9799***

Table 27: Heckman selection model coefficients from the wage change model for men. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
Wage change equation				
$\sinh^{-1}$(Housing wealth)	0.1955	0.2220	0.2125	0.2181
$\sinh^{-1}$(Other wealth)	0.0079	0.0132	0.0132	0.0151
Age spline (50–54)	0.1945	0.2069	0.1974	0.2126
Age spline (55–59)	−0.0893	−0.0772	−0.0582	−0.0762
Age spline (60–64)	−1.4707**	−1.4809**	−1.4853**	−1.4770**
Age spline (65–70)	−2.6745*	−2.6660*	−2.5561*	−2.5842*
Health limitation	−1.3360	−1.2574	−1.2735	−1.2945
Education = degree	3.3187	3.2047	3.2949	3.2725
Education = other HE	3.3333	3.2020	3.2854	3.2423
Education = A levels	1.9045	1.8579	1.8417	1.8601
Education = O levels	1.9106	1.9134	1.9596	1.9362
Education = NVQ1/CSE	3.3218	3.1334	3.1391	3.1431
Education = other	2.9520	2.9226	2.9225	2.9029
Married	−0.4499	−0.5380	−0.5031	−0.5364
Outright owners	−1.5867	−1.9330	−1.8188	−1.8828
Owners with mg/loan	−0.1069	−0.4576	−0.2974	−0.3758
Occ = prof/man/tech	0.4202	0.4092	0.4223	0.3813
Occ = non-man skilled	−0.5650	−0.6666	−0.6149	−0.6641
Occ = manual skilled	0.5901	0.5375	0.5561	0.5296
Household size	0.1237	0.1516	0.1398	0.1589
D.(Date score)	1.2156			
D.(Immediate recall)	−0.2226	−0.2206		
D.(Verbal fluency)	−0.0073	−0.0004		
D.(Prospective memory)	−0.3059	−0.3093		
D.(Delayed recall)	−0.0734	−0.0966		
D.(CF index)			−0.1813	
D.(CF index w/o date)				−0.2866
Constant	−17.9967	−18.5941	−18.2124	−18.9681
Sample retention equation				
Age spline (50–54)	0.0195	0.0188	0.0190	0.0181
Age spline (55–59)	−0.0598**	−0.0613**	−0.0579**	−0.0593**
Age spline (60–64)	−0.0733**	−0.0734**	−0.0730**	−0.0732**
Age spline (65–70)	−0.3535***	−0.3532***	−0.3552***	−0.3548***
Health limitation	−0.3571***	−0.3608***	−0.3563***	−0.3602***
R consulted docs	0.0927**	0.0968**	0.0949**	0.0980**
Response reliability	−0.0383	−0.0369	−0.0377	−0.0368
R gave contact address	0.0710	0.0724	0.0704	0.0698
R agreed to record linkage	0.3882***	0.3868***	0.3897***	0.3868***
Date score	0.1056			
Immediate recall	0.0521**	0.0527**		
Verbal fluency	0.0106*	0.0110*		
Prospective memory	0.0579***	0.0600***		
Delayed recall	0.0211	0.0229		
CF index			0.0706***	
CF index w/o date				0.0740***
Constant	−2.0041	−1.5888	−0.7471	−0.6900
Number of obs.	1,988	1,988	1,988	1,988
Log likelihood	−5429.997	−5431.864	−5431.64	−5432.651
ρ	0.6450***	0.6449***	0.6410***	0.6431***

Table 28: Heckman selection model coefficients from the wage change model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
ln(Wage) equation				
$\sinh^{-1}$(Housing wealth)	0.0186*	0.0186*	0.0183*	0.0179*
$\sinh^{-1}$(Other wealth)	0.0077**	0.0078**	0.0075**	0.0074**
Age spline (50–54)	−0.0339	−0.0334	−0.0308	−0.0321
Age spline (55–59)	0.0292*	0.0296*	0.0283	0.0288
Age spline (60–64)	0.0306	0.0314	0.0304	0.0307
Age spline (65–70)	0.1025***	0.1022***	0.1030***	0.1036***
Health limitation	0.3867***	0.3892***	0.3826***	0.3838***
Education = degree	0.3247***	0.3281***	0.3313***	0.3316***
Education = other HE	0.1948***	0.1998***	0.1956***	0.1960***
Education = A levels	0.0721	0.0735	0.0722	0.0729
Education = O levels	0.0933	0.0950	0.0932	0.0952
Education = NVQ1/CSE	−0.0445	−0.0435	−0.0365	−0.0379
Education = other	−0.1653	−0.1574	−0.1678	−0.1642
Married	−0.0889	−0.0875	−0.0841	−0.0858
Outright owners	−0.2217	−0.2182	−0.2164	−0.2123
Owners with mg/loan	−0.1554	−0.1532	−0.1500	−0.1450
Occ = prof/man/tech	0.3618***	0.3595***	0.3630***	0.3637***
Occ = non-man skilled	0.0320	0.0271	0.0271	0.0278
Occ = manual skilled	0.0657	0.0652	0.0636	0.0646
Household size	0.0119	0.0124	0.0133	0.0130
L.(Date score)	−0.0191			
L.(Immediate recall)	0.0123	0.0121		
L.(Verbal fluency)	0.0027	0.0028		
L.(Prospective memory)	−0.0020	−0.0027		
L.(Delayed recall)	0.0193	0.0185		
L.(CF index)			0.0155*	
L.(CF index w/o date)				0.0188**
Constant	3.4494	3.3534	3.4152	3.4858
Sample retention equation				
Age spline (50–54)	0.1201	0.1120	0.1125	0.1102
Age spline (55–59)	−0.0897***	−0.0885***	−0.0883***	−0.0886***
Age spline (60–64)	−0.1872***	−0.1870***	−0.1871***	−0.1873***
Age spline (65–70)	−0.2269***	−0.2279***	−0.2254***	−0.2264***
Health limitation	−1.0704***	−1.0732***	−1.0633***	−1.0680***
L.(Hours given care to others)	−0.0015*	−0.0015*	−0.0016*	−0.0016*
Date score	0.0865			
Immediate recall	0.0196	0.0218		
Verbal fluency	0.0072	0.0075		
Prospective memory	−0.0217	−0.0198		
Delayed recall	0.0004	0.0011		
CF index			0.0189*	
CF index w/o date				0.0163
Constant	−5.8780	−5.1476	−4.9639	−4.8364
Number of obs.	2,250	2,250	2,250	2,250
Log likelihood	−2104.441	−2105.602	−2108.036	−2108.309
ρ	−0.7489***	−0.7516***	−0.7447***	−0.7457***

Table 29: Heckman selection model coefficients from the ln(wage) model for men. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
ln(Wage) equation				
$\sinh^{-1}$(Housing wealth)	0.0139	0.0139	0.0141	0.0141
$\sinh^{-1}$(Other wealth)	0.0061*	0.0061*	0.0062*	0.0062*
Age spline (50–54)	0.0213	0.0204	0.0187	0.0185
Age spline (55–59)	0.0086	0.0106	0.0124	0.0126
Age spline (60–64)	−0.0393*	−0.0340	−0.0317	−0.0310
Age spline (65–70)	−0.0326	−0.0299	−0.0255	−0.0252
Health limitation	−0.0122	0.0020	0.0145	0.0165
Education = degree	0.4875***	0.4875***	0.4914***	0.4921***
Education = other HE	0.3809***	0.3814***	0.3877***	0.3883***
Education = A levels	0.0875	0.0872	0.0890	0.0894
Education = O levels	0.0832	0.0830	0.0834	0.0837
Education = NVQ1/CSE	0.1426	0.1444	0.1448	0.1451
Education = other	0.1186	0.1191	0.1213	0.1215
Married	0.0212	0.0213	0.0217	0.0217
Outright owners	−0.2278	−0.2289	−0.2287	−0.2289
Owners with mg/loan	−0.2166	−0.2167	−0.2158	−0.2158
Occ = prof/man/tech	0.1719**	0.1710**	0.1686**	0.1689**
Occ = non-man skilled	0.1126*	0.1120*	0.1119*	0.1123*
Occ = manual skilled	0.0404	0.0394	0.0382	0.0383
Household size	0.0213	0.0214	0.0210	0.0211
L.(Date score)	0.0151			
L.(Immediate recall)	0.0052	0.0053		
L.(Verbal fluency)	−0.0004	−0.0003		
L.(Prospective memory)	−0.0074	−0.0077		
L.(Delayed recall)	0.0048	0.0045		
L.(CF index)			0.0024	
L.(CF index w/o date)				0.0020
Constant	0.1647	0.2824	0.3953	0.4112
Sample retention equation				
Age spline (50–54)	0.0522	0.0534	0.0535	0.0542
Age spline (55–59)	−0.1323***	−0.1325***	−0.1320***	−0.1324***
Age spline (60–64)	−0.2062***	−0.2077***	−0.2019***	−0.2034***
Age spline (65–70)	−0.0812***	−0.0794***	−0.0794***	−0.0797***
Health limitation	−0.7093***	−0.7120***	−0.6915***	−0.6964***
L.(Hours given care to others)	−0.0035***	−0.0036***	−0.0035***	−0.0035***
Date score	0.3324***			
Immediate recall	0.0514**	0.0543**		
Verbal fluency	−0.0035	−0.0023		
Prospective memory	0.0594***	0.0609***		
Delayed recall	−0.0284	−0.0214		
CF index			0.0369***	
CF index w/o date				0.0308***
Constant	−3.5484	−2.4097	−2.0398	−2.0609
Number of obs.	2,908	2,908	2,908	2,908
Log likelihood	−2587.083	−2596.235	−2599.771	−2602.664
ρ	0.1479	0.0981	0.0631	0.0559

Table 30: Heckman selection model coefficients from the ln(wage) model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
ln(Earnings) equation				
$\sinh^{-1}$(Housing wealth)	0.0198*	0.0197*	0.0194*	0.0191*
$\sinh^{-1}$(Other wealth)	0.0074**	0.0075**	0.0072**	0.0071**
Age spline (50–54)	−0.0374	−0.0371	−0.0344	−0.0354
Age spline (55–59)	0.0235	0.0239	0.0228	0.0233
Age spline (60–64)	0.0339	0.0347	0.0339	0.0344
Age spline (65–70)	0.0620*	0.0619*	0.0607*	0.0612*
Health limitation	0.4026***	0.4052***	0.3981***	0.3996***
Education = degree	0.2870***	0.2914***	0.2925***	0.2941***
Education = other HE	0.1942**	0.2001***	0.1927**	0.1941**
Education = A levels	0.0955	0.0979	0.0994	0.1010
Education = O levels	0.0800	0.0833	0.0838	0.0868
Education = NVQ1/CSE	−0.0377	−0.0369	−0.0275	−0.0288
Education = other	−0.1807	−0.1721	−0.1805	−0.1768
Married	−0.0893	−0.0888	−0.0843	−0.0861
Outright owners	−0.2372	−0.2339	−0.2300	−0.2262
Owners with mg/loan	−0.1625	−0.1599	−0.1549	−0.1502
Occ = prof/man/tech	0.3717***	0.3706***	0.3720***	0.3734***
Occ = non-man skilled	0.0454	0.0419	0.0418	0.0433
Occ = manual skilled	0.1104	0.1108	0.1069	0.1082
Household size	0.0143	0.0147	0.0148	0.0145
Weekly working hours	0.0289***	0.0289***	0.0289***	0.0289***
L.(Date score)	−0.0080			
L.(Immediate recall)	0.0002	−0.0000		
L.(Verbal fluency)	0.0015	0.0016		
L.(Prospective memory)	0.0018	0.0010		
L.(Delayed recall)	0.0264*	0.0258		
L.(CF index)			0.0147	
L.(CF index w/o date)				0.0172*
Constant	6.1452	6.0964	6.1080	6.1573
Sample retention equation				
Age spline (50–54)	0.1132	0.1054	0.1060	0.1039
Age spline (55–59)	−0.0867***	−0.0854***	−0.0852***	−0.0854***
Age spline (60–64)	−0.1859***	−0.1856***	−0.1856***	−0.1859***
Age spline (65–70)	−0.2244***	−0.2254***	−0.2231***	−0.2241***
Health limitation	−1.0627***	−1.0655***	−1.0558***	−1.0603***
L.(Hours given care to others)	−0.0013	−0.0013	−0.0014	−0.0014
Date score	0.0837			
Immediate recall	0.0238	0.0261		
Verbal fluency	0.0071	0.0074		
Prospective memory	−0.0224	−0.0205		
Delayed recall	−0.0048	−0.0043		
CF index			0.0173*	
CF index w/o date				0.0147
Constant	−5.5160	−4.8105	−4.6379	−4.5219
Number of obs.	2,250	2,250	2,250	2,250
Log likelihood	−2124.568	−2125.66	−2128.292	−2128.693
ρ	−0.7849***	−0.7877***	−0.7807***	−0.7815***

Table 31: Heckman selection model coefficients from the ln(earnings) model for men. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

	(1)	(2)	(3)	(4)
ln(Earnings) equation				
$\sinh^{-1}$(Housing wealth)	0.0091	0.0091	0.0090	0.0089
$\sinh^{-1}$(Other wealth)	0.0034	0.0034	0.0034	0.0034
Age spline (50–54)	0.0224	0.0213	0.0202	0.0199
Age spline (55–59)	−0.0096	−0.0070	−0.0045	−0.0039
Age spline (60–64)	−0.0648***	−0.0584**	−0.0531**	−0.0519*
Age spline (65–70)	−0.0216	−0.0182	−0.0152	−0.0145
Health limitation	−0.0343	−0.0161	−0.0008	0.0030
Education = degree	0.4316***	0.4318***	0.4280***	0.4287***
Education = other HE	0.2643***	0.2647***	0.2616***	0.2622***
Education = A levels	0.0715	0.0716	0.0704	0.0708
Education = O levels	0.0593	0.0593	0.0589	0.0591
Education = NVQ1/CSE	0.0993	0.1004	0.0978	0.0980
Education = other	0.1231*	0.1236*	0.1227*	0.1228*
Married	−0.0387	−0.0389	−0.0393	−0.0393
Outright owners	−0.2004	−0.2014	−0.1999	−0.1999
Owners with mg/loan	−0.1433	−0.1433	−0.1413	−0.1410
Occ = prof/man/tech	0.3198***	0.3191***	0.3177***	0.3179***
Occ = non-man skilled	0.2466***	0.2459***	0.2445***	0.2450***
Occ = manual skilled	0.1273	0.1267	0.1259	0.1261
Household size	0.0293	0.0295	0.0294	0.0294
Weekly working hours	0.0335***	0.0335***	0.0335***	0.0335***
L.(Date score)	0.0112			
L.(Immediate recall)	0.0048	0.0048		
L.(Verbal fluency)	−0.0006	−0.0005		
L.(Prospective memory)	0.0040	0.0036		
L.(Delayed recall)	0.0022	0.0019		
L.(CF index)			0.0037	
L.(CF index w/o date)				0.0036
Constant	2.3987	2.5208	2.6316	2.6511
Sample retention equation				
Age spline (50–54)	0.0525	0.0536	0.0537	0.0544
Age spline (55–59)	−0.1324***	−0.1325***	−0.1319***	−0.1323***
Age spline (60–64)	−0.2062***	−0.2077***	−0.2021***	−0.2035***
Age spline (65–70)	−0.0812***	−0.0793***	−0.0793***	−0.0795***
Health limitation	−0.7092***	−0.7117***	−0.6915***	−0.6963***
L.(Hours given care to others)	−0.0035***	−0.0035***	−0.0035***	−0.0035***
Date score	0.3317***			
Immediate recall	0.0510**	0.0541**		
Verbal fluency	−0.0037	−0.0024		
Prospective memory	0.0594***	0.0606***		
Delayed recall	−0.0278	−0.0206		
CF index			0.0371***	
CF index w/o date				0.0313***
Constant	−3.5629	−2.4231	−2.0516	−2.0720
Number of obs.	2,908	2,908	2,908	2,908
Log likelihood	−2564.839	−2573.879	−2576.989	−2579.854
ρ	0.1104	0.0464	−0.0050	−0.0181

Table 32: Heckman selection model coefficients from the ln(earnings) model for women. ***: Statistically significant at the 1% level; **: 5% level; *: 10% level.

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